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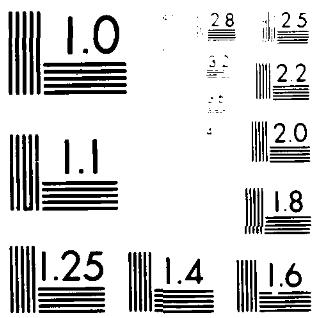

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ARCHAEOLOGICAL INVESTIGATIONS
AT THE
SAN GABRIEL RESERVOIR DISTRICTS,
CENTRAL TEXAS

VOLUME 2

Institute of Applied Sciences
North Texas State University
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1982

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This report presents the results of archaeological investigations conducted by North Texas State University at two Corps of Engineers reservoirs on the San Gabriel River in Central Texas. The archaeology project consisted of site survey, evaluation, and data recovery of endangered cultural resources at North Fork and Granger Reservoirs. Eighty new prehistoric and one hundred historic sites were recorded, of which nine prehistoric and thirteen historic sites had further study. Additional research involved the Hoxie Ranch, and evaluations

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cont

of a Paleo-Indian site (41WM419), and the Cervenka Site (41WM267).

The two reservoirs, locatedin different environmental zones, offered an opportunity to examin varying human adaptations. First, the cultural patterns of the two reservoirs were delineated. Next, the adaptive patterns and artifact assemblages were compared to determine if the two reservoirs were part of the same cultural area.

Contributions to Central Texas archaeology include: 1) the chronology of human occupation has been augmented by thirty-seven new radiocarbon dates; 2) an alternative to current models of prehistoric adaptation for the area is proposed; 3) an interpretation of the occurrence of burned rock middens has been presented; 4) an evaluation of the "phase" concept in Central Texas indicated the geographical boundaries of the phases varied through time.

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V. ARCHAEOLOGICAL DATA ANALYSIS

14.0 Artifact Analyses

This section contains the results of artifact descriptions and analyses. Artifact descriptions are an essential part of any archaeological endeavor. The typology of stone tools is particularly important in characterizing sites for comparison. It is necessary to examine the total range of cultural materials from a site, not just concentrate on the projectile points.

Traditionally, archaeologists in Texas have each used their own typological system for individual projects. Consequently, comparability of assemblages is almost impossible at times, for no standardized typology exists. The typological system used in the San Gabriel Project is a morphological typology which allows for adequate inter-assemblage comparability.

The artifacts are described in detail so that other researchers can use the descriptions to compare the San Gabriel artifacts with other artifacts even if a different typology is used. It is hoped these artifact analyses will provide new data for understanding man's past, as well as enhancing communication among researchers in Central Texas.

14.1 Projectile Point Classification

by

Duane E. Peter

Introduction

Over twenty-five years have passed since the initial publication of proposed projectile point types for Central Texas (Suhm , et. al 1954). Although many archaeologists today attempt to avoid the traditional reliance upon projectile points as index fossils, the dependence upon a knowledge of the spatial and temporal distribution of projectile point styles is still necessary for the reconstruction of culture history. This is particularly true in areas such as Central Texas where radiocarbon samples are not always available. The temporal comparability of assemblages often can be established only through the presence of stylistically similar projectile point forms.

The establishment of temporal comparability of assemblages requires the consistent recognition of projectile point forms. Unfortunately, projectile point morphology is quite variable within Central Texas. In order to maintain comparability with previous investigations in Central Texas, the sample of 715 projectile points (whole and fragmentary) was subjectively classified according to the guidelines provided by the Handbook of Type Descriptions (Suhm and Jelks 1962). Individual specimens are classified on the basis of several gross morphological characteristics (beveling, concave stem bases, flared stems, corner or side notches, etc) which are shared with other specimens. Suhm and Jelks (1962:viii) emphasize that their defined types are not merely descriptive categories; rather, they are cultural types which must be supported by distributional data (both geographical and temporal). Although they do not label their types as Historic Index Types (Steward 1954; Krieger 1944), their concern with "continuity in distribution of a type" reflects such an implicit purpose. The observation that projectile point form tends to change through time and over space enables archaeologists to use them as indicators of temporal, spatial, or cultural variability. These characteristics are not commonly found among other categories of chipped stone tools in Central Texas (Johnson 1967).

Contrary to the warnings of Suhm and Jelks (1962), the type descriptions have served as guides for "pigeon-holing" artifacts for some investigators,while others have avidly created types and split others into several varieties. Far too frequently,researchers have either not recognized the variability represented by their samples or have failed to present the distributional data needed to support new types. More cautious investigators, when recognizing morphological variability outside the presently recognized types, have usually presented similar points from a given project area as descriptive categories.

Similarities to specimens or groups described elsewhere are usually noted, but type designations are avoided due to a lack of personal familiarity with the materials from a larger area. Such is the approach that will be utilized here. When the variability of the San Gabriel specimens is within the range of variability of types previously defined in the literature, those type designations are used. For those specimens or groups of points which lie outside the presently defined range of variability, arbitrary descriptive category designations are utilized (Group 1, 2, etc). Previously designated types, familiar entities to Texas archaeologists, will not be discussed further here unless new distributional data are presented or there is a need to express concern regarding the present utilization of a type name.

Triangular Projectile Points

Sixteen triangular projectile points were recovered from three sites within the North Fork and Granger Lake Reservoirs. Eleven of these specimens are traditionally recognized as "Tortugas points." The considerable variability of these specimens and the utility of the term, "Tortugas," are discussed. The remaining five specimens are the product of a much later occupation of the Hawes Site. Although these Fresno points are very simple and homogeneous in style, post-depositional processes affecting their context have severely limited the information derived from these specimens and the associated materials.

"Tortugas" Specimens

The most distinctive of the triangular points recovered from the San Gabriel assemblages is the "Tortugas" point. Unlike many sites in south central Texas, the San Gabriel River assemblages consistently yield these points from an Early Archaic context. Eleven specimens (Table 14.1-1) were recovered from three sites: the Cervenka Site (41WM267), the Hawes Site (41WM56), and site 41WM304. Considerable variability is exhibited within this small sample.

The stratigraphic positions of the three specimens from the Cervenka Site (Fig. 14.1-1) allow a view (biased as it may be) of their morphological variability from a diachronic perspective. The earliest specimen (Figure 14.1-1a) is a simple triangular biface with slightly recurved edges. The base of the specimen is straight and has been bifacially thinned. The second specimen (Figure 14.1-1i), deposited later within the San Geronimo stratigraphic unit, shows different retouch characteristics. Although triangular in form, the original block of raw material was not bifacially worked over its entire surface. Only the marginal edges of one side of the specimen have been finely retouched. The other surface of the specimen has been completely altered. The lateral edges have been retouched to produce serration. The base is concave in shape and has been bifacially thinned.

The third specimen, (Figure 14.1-1d) apparently deposited later in the Clear Fork occupation of the site, is much shorter than the others.

	Tortugas Points											Fresno Points				
	Site 41WM56			Site 41WM304					Site 41WM267			Site 41WM56				
Area	B	D	B	SP1	B	B	SP1	B	D	D	A	B	B	B	B	B
Level	9	9	11	2	8	7	2	8	103/104	85/86	14	3	2	2	1	1
Catalog No.	1908	943	1757	57	52	40	44	21	1054	1055	739	1174	1258	1257	534	1569
Figure	g	e	f	b		h	c		a	i	d					
Length	59	37	30	57	-	42	47	45	67	-	40	-	26	-	-	-
Width	40	-	32	41	35	38	33	42	35	32	37	18	14	16	12	20
Thickness	8	6.5	5	6	11	8	5.5	6	6	7.5	5.5	3	3	5	2	7
Weight	17.1	-	5	13.7	-	11.7	8.1	10.6	14.1	-	6.9	-	1.0	-	-	-

Linear dimensions are measured to the nearest .5 mm.

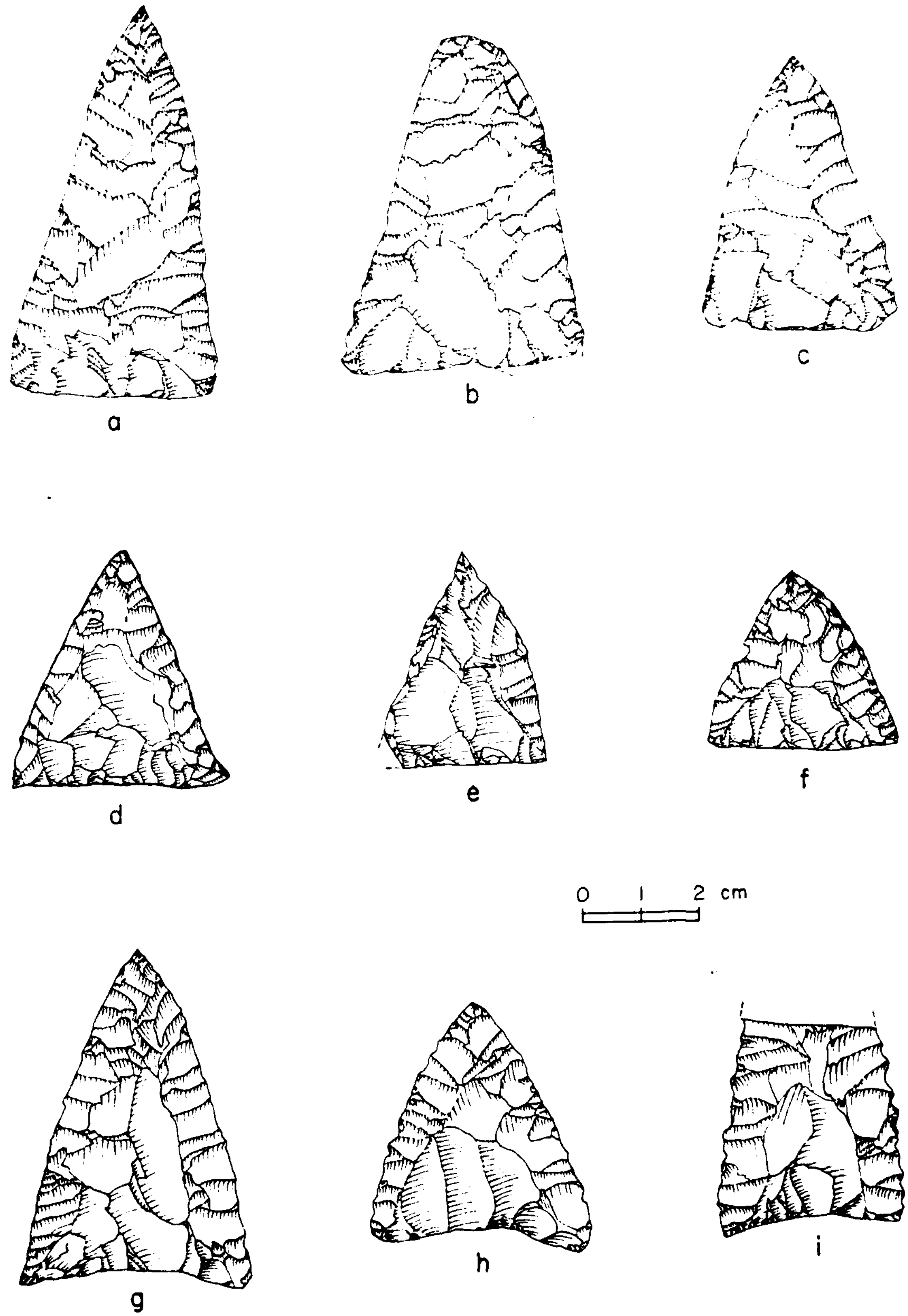
Weight is measured to the nearest .1 gm.

Table 14.1-1. Dimensions of triangular projectile points recovered from Granger Lake and North Fork Lake assemblages.

FIGURE 14.1-1

STONE TOOLS: PROJECTILE POINTS.

	Site	Type
a	41WM267	Tortugas.
b	41WM304	Tortugas.
c	41WM403	Tortugas.
d	41WM267	Tortugas.
e	41WM56	Tortugas.
f	41WM56	Tortugas.
g	41WM56	Tortugas.
h	41WM304	Tortugas.
i	41WM267	Tortugas.



14.1-1

Again, this specimen is a simple triangular biface with one convex edge and one recurved edge. The base is concave and has been bifacially thinned. The alternate right edges of this specimen exhibit a slight beveled appearance.

The five specimens from site 41WM304 in the North Fork Reservoir are also from a San Geronimo or Clear Fork stratigraphic unit. Unfortunately, the lack of radiometric dates and the recovery of two of these specimens from uncontrolled excavations renders an evaluation of temporally related stylistic changes very difficult. Nevertheless, similarities to the Tortugas specimens from the Cervenka Site are noted.

Like the earliest specimen from the Cervenka Site, one point (Figure 14.1-1b) from site 41WM304 is a simple triangular biface. The lateral edges are recurved. The base, which has been bifacially thinned, is slightly convex in shape. The distal end of this specimen is rounded rather than pointed.

Elsewhere, within the second step of the stepped profile, a much smaller, triangular specimen (Figure 14.1-1c) has alternate beveling of the right edges. The lateral edges are recurved or convex. The straight basal edge is characteristically bifacially thinned. A similar specimen was recovered from Level 8 of excavation unit B. The alternate level of the right edges is not nearly as steep however, the retouch of one right edge has produced a "denticulate" edge. Although a portion of the distal tip is missing, it appears to have been rounded.

The other specimen recovered from Level 8, unlike the others, has a well developed patina. Although this specimen is regular in outline, the lack of fine secondary retouch and its overall thickness may indicate that it is a preform.

The last specimen (Figure 14.1-1h), recovered from Level 7 of excavation unit B, is unique for this site as its convex lateral edges are serrated and alternate beveling appears on the left edges rather than on the right. The basal edge also is concave. These characteristics, except for the beveling, are similar to those of one of the specimens from the San Geronimo stratigraphic unit at the Cervenka Site. However, from a diachronic perspective the only stylistic change that is noticeable is that the earliest specimens are generally larger and more simple in form.

The three Tortugas specimens from the Hawes Site (41WM56) have a similar range of characteristics. Two specimens from the probable San Geronimo stratigraphic unit in Area B show considerable variability. The specimen from Level 9 (Figure 14.1-1g) is significantly larger than the others. Like one of the specimens from the Cervenka Site, this piece exhibits a surface which has not been completely altered by secondary retouch. Retouch of the lateral edges has produced a very sinous cutting edge. The concave base of this specimen is characteristically bifacially thinned.

The other specimen (Figure 14.1-1f) from Level 11 of Area B is significantly smaller in size. This specimen has a simple triangular form with convex lateral edges. The alternate right edges are very slightly beveled. The basal edge is straight and bifacially thinned.

The remaining specimen (Figure 14.1-1e) from Area D (Level 9) is similarly small in size and has a straight, bifacially thinned base. The steep beveling of the alternate right edges, however, give it a shape and profile which is very similar to that of a specimen from site 41WM304. The beveling of the lateral edges of these specimens likely served as a resharpening technique.

The considerable variability of these artifacts has traditionally been subsumed under the term, Tortugas (Suhm, et. al 1954:482). As Sorrow (1969:19) has aptly noted, the term, "Tortugas," embraces what Kelley (1947a) has referred to as "Baird Beveled Blade" and "Taylor Thinned Base" within the Edwards Plateau Aspect and the "Tortugas Triangular Blade" within southwestern Texas. As a cultural-historical type or index fossil, the term Tortugas is not as useful as it might be due to the lack of spatial and temporal specificity associated with its usage. Tortugas points, as presently recognized, may be associated with the Falcon Focus of southwest Texas, the Alto Focus of east Texas, or the Archaic stage of central and southwest Texas (Suhm and Jelks 1962:249).

Since all of the specimens from the San Gabriel assemblages are from an Early Archaic context, the encompassing term, Tortugas, as presently defined, does not seem appropriate. Sorrow (1969:19) recognized this problem in analyzing the John Ischy Site specimens, for he suggested that the Tortugas type be subdivided into descriptive categories. The provisional type names, Baird and Taylor, were suggested for Central Texas. Interestingly, these provisional types do not encompass the variability exhibited by the eleven specimens recovered from site 41WM304, the Hawes Site and the Cervenka Site.

Three discrete groups of variability are recognizable within the sample recovered. Two of the specimens, one from the Cervenka Site (Figure 14.1-1a) and the other from site 41WM304 (Figure 14.1-1b), comprise Group I. These specimens share characteristics of Sorrow's "Taylor" (1969:18-19, 23) specimens and Shafer's "Untyped III" specimens (Sorrow et al. 1967:21-22). Both are thin triangular bifaces with no beveling of the lateral edges. These two specimens are stratigraphically below any of the more typical "Tortugas" specimens recovered from these sites.

Group II consisting of five specimens, resembles specimens from both the Landslide Site (Sorrow et al. 1967:19-20) and the John Ischy Site (Sorrow 1969:18-19, 23). These specimens (Fig. 14.1-1 c, d, e, f) exhibit straight bases and generally convex lateral edges. Beveling of the right alternate edges is present on all specimens although the angle of the bevel varies considerably. Sorrow (1969:19) would have designated these specimens as representative of the "Baird" type.

Group III, consisting of three specimens (one from each site), differ from previously described "Tortugas" specimens. These specimens (Figure 14.1-1g, h, i) are thicker in cross-section (7.5-8.0 mm) and have serrated lateral edges (2 specimens) and concave bases. Beveling is quite variable, for one specimen shows no beveling while the other two specimens have alternate beveling of the right and left edges respectively. The overall shape of these specimens is also more symmetrical than the others. The one large specimen within Shafer's "Untyped Group III" (Sorrow et al. 1967:21-22, Figure 14.1-1f) from the Landslide Site most closely resembles these specimens from the San Gabriel assemblages.

These three groups adequately depict the range of variability within the sample of "Tortugas" specimens from the San Gabriel assemblages. The temporal specificity of these specimens within Central Texas raises serious questions regarding the usage of the term, "Tortugas," as it is presently defined. Nevertheless, the proposal of new type names on the basis of such a limited sample is not justified at this time. These three descriptive categories or groups will serve as references for other researchers in Central Texas as adequately as a new list of confusing type designations.

Interestingly, the three groups do not represent diachronic changes in stylistic variability. Group I (the thin, triangular pieces) is the only group that appears to be temporally distinctive. From a spatial perspective all three groups are found both in the prairie environment of the Granger Lake Reservoir and the Edwards Plateau environment of the North Fork Reservoir. Therefore, the cultural significance of the variability is not easily explained. The functional requirements of these tools and the social interaction of their makers were likely the most important factors affecting their overall morphological variability. Presently, the former factor, that of function, is the only one that can be reasonably investigated. An analyst specializing in use-wear studies may be able to determine whether or not the traditional assumption that the "Tortugas" specimens were used as projectile points is warranted. Such studies may well reveal that many of these specimens were used as knives rather than projectiles.

Fresno Specimens

The remainder of the triangular projectile points recovered from the San Gabriel assemblages are all from the Hawes site (41WM56). These fragmentary pieces (Table 14.1-1) represent a late Neo-American occupation of the site. The presence of ceramics, in addition to these points, within the plowzone of this site suggests that the points were likely deposited subsequent to 650 B.P.

All of these artifacts are simple triangular forms with straight to slightly concave bases. Four of the specimens are finely flaked on both faces. The remaining pieces have one face which is the smooth fracture plane of the original flake. Although the concavity of the basal edge of this specimen suggests that it may be a Talco point, the lack of fine bifacial retouch makes the Fresno designation more likely.

Unfortunately, the lack of a primary context for these artifacts precludes a more exact temporal designation. Given the association of a ceramic pipe bowl fragment, these Fresno points may well represent the latest prehistoric occupation of the North Fork drainage. A post-450 B.P. date for these specimens would not be surprising. Nevertheless, such statements are largely conjectural since post-depositional processes have destroyed their primary context. This is particularly unfortunate because the Neo-American component is not well represented at the North Fork sites.

Stemmed Projectile Points

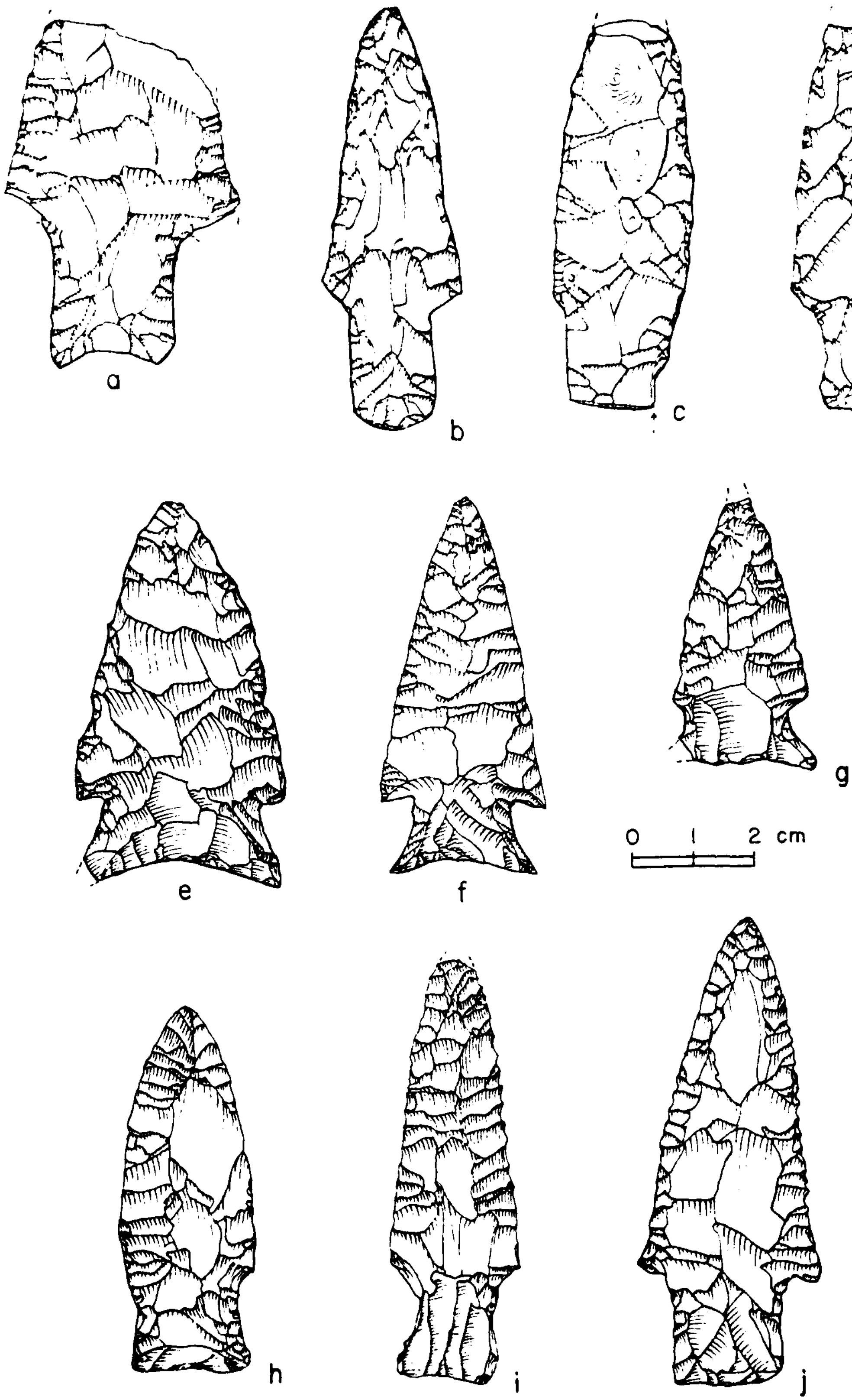
Andice

Andice (1 specimen; Fig. 14.1-2a): Like the Hoxie points, this type has been previously defined in the Rogers Springs report (Prewitt 1976b). This fragmentary specimen exhibits fine secondary retouch along the blade and stem edges as the type specimens do. The remnant blade edges are finely serrated. The characteristic massive wings are no longer present on this particular specimen. Like the type specimens, the stem exhibits basal thinning which results in a concave base.

FIGURE 14.1-2

STONE TOOLS: PROJECTILE POINTS.

	Site	Type
a	41WM267	Andice.
b	41WM267	Dawson, group A.
c	41WM267	Dawson, group B.
d	41WM267	Dawson, group C.
e	41WM53	Fairland.
f	41WM328	Fairland/Ensor.
g	41WM56	Fairland/Ensor.
h	41WM267	Hoxie.
i	41WM267	Hoxie.
j	41WM267	Hoxie.


a
b
c
d
e
f
g
0 1 2 cm
h
i
j

This single specimen was recovered from the San Geronimo component of excavation unit A at the Cervenka Site (41WM267). It was in a level immediately underlying those containing Hoxie points. Assuming that the Hoxie points recovered from excavation unit D are relatively contemporaneous with those in unit A, the Andice point should have been deposited around 5000 B.P. Interestingly, the Andice points are morphologically similar to Calf Creek points found much farther north in Oklahoma, Arkansas, and Missouri during this same time period (Bell 1958, 1960).

Dawson

Dawson (14 specimens; Fig. 14.1-2b-d): All of these specimens were recovered from the Cervenka Site. Their assignment to the classificatory type, "Dawson," is based on a limited set of shared characteristics with the originally defined type (Duffield 1963:17-18) and the subsequent type-variety classifications proposed by Prewitt (1974:58-62) for projectile points recovered from the Upper Navasota Reservoir. The type as defined by Prewitt (1974:58-62) encompasses a significant amount of morphological variability. Prewitt recognizes this variability by assigning four variety names: kosse, marquez, mexia, and strawn. Nevertheless, the Upper Navasota River specimens appear to differ significantly (on the basis of general form) from those originally grouped from Strawn Creek. The only characteristics tying the two groups together are the unmodified stem bases, the light grinding of the stems, and the flared shoulders of some specimens of each group. These characteristics, however, do not pervade the entire sample of Dawson points. Neither do they pervade this sample of projectile points from the Cervenka Site. Selective characteristics, such as the lack of modification of the stem bases and the grinding of the stems, are represented within this sample. The significance of these characteristics in defining a supposedly homogeneous cluster of artifacts, however, is brought into question when the overall morphological variability of the sample is so high.

Therefore, the term "Dawson" is used with some reluctance, especially since the original type definitions are based on a sample of projectile points from secondary archaeological contexts. The proveniences of the artifacts from the Strawn Creek site (Duffield 1963:60-62) indicate a very mixed assemblage with Dawson points equally associated with Early Archaic projectile points, arrow points, and ceramic sherds. Similarly, the projectile points from the Upper Navasota Reservoir survey are assumed to be from surface collections (Prewitt 1974) which may not represent primary contexts. The culture-historical context of the "Dawson" type specimens is, therefore, unknown. Consequently, whether the morphological variability of the type sample is due to diachronic stylistic trends or

synchronic cultural preferences is unclear. The only apparent conclusion that can be made at this time regarding the spatial distribution of the type sample as a whole is that their occurrence is presently limited to the area east of the Balcones Escarpment.

The specimens from the Cervenka Site which share a limited set of characteristics with the original type specimens provide the only primary contextual information regarding the "Dawson" type. All of the Cervenka specimens, except two, are associated with the Clear Fork component. The two exceptions were recovered from the San Marcos stratigraphic units of areas A and B. These two specimens are not particularly distinctive in relation to the earlier Clear Fork specimens. Whether the resemblance of the San Marcos specimens to the earlier assemblage is fortuitous or represents a continuity in stylistic preferences can only be determined through the recovery of similar specimens from other primary contexts. Once the culture-historical context of the variability within the "Dawson" type is more fiemly established, it may be judged that distinctive type names would more adequately reflect the observed variability. The creation of new type-variety designations for the variability exhibited among the Cervenka specimens is, therefore, considered inappropriate at this time.

Group A (4 specimens; Figure 14.1-2b): these four fragmentary specimens from the Cervenka Site have narrow blades with convex to recurved edges. Strong shoulders mark the transition to narrow stems with parallel straight or convergent edges. Bases are convex. One stem edge exhibits light grinding.

Although these specimens do not resemble the Dawson type as originally described by Duffield (1963:17-18), they do resemble the "Dawson kosse" as described by Prewitt (1974:58, Figure 5). Light grinding of the stem and basal edges is not as predominant within the Cervenka sample, however. Shoulders do not flare as much either. Two of the specimens are made of a low grade chert not typically utilized for artifacts within the Granger Reservoir.

Group B (4 specimens; Figure 14.1-2c): these specimens exhibit broader blades than the above group. The convex blade edges are more regular in form. Shoulders are very weak, for the blade/stem transition is marked only by the decreasing breadth of the specimen near its proximal end. The straight edges converge slightly. The bases of two stems are unmodified cortex. The stem edges of these two specimens have been ground. Unlike the above group, all of the stem bases are straight. The bases of the remaining two specimens show snap scars.

These specimens are unlike any of the previously defined Dawson varieties. Since three of the specimens display snap fractures of the blade which may have resulted from end shock during manufacture, they may be nothing more than preforms. Nevertheless, two of the four specimens share the characteristics of ground stem edges and unmodified bases with previously recognized Dawson points.

<u>Group C</u> (8 specimens;Figure 14.1-2d): this less than homogeneous group of points shares some of the characteristics of the Dawson type as originally defined by Duffield (1963:17-18). All of the specimens have straight to slightly convex stem bases which range from totally unmodified (6) to 99 percent modified (2) with only a small area of cortex remaining. Stem edges are lightly ground on only three specimens. Stem edges, irregular in form, range from straight to concave. On the specimens which still exhibit the area of blade-stem transition, one shoulder is typically less prominent than the other.

The two complete specimens of this group have varying blade forms. One specimen exhibits a narrow triangular blade while the other possesses a more assymetrical and ovate shaped blade. The left edge of each blade has been beveled.

Fairland/Ensor

Fairland/Ensor (68 specimens; Figure 14.1-2e-g): The term "Fairland/ Ensor" as it is used here is not intended as a new type-variety designation; rather it is used as a "descriptive" designation for a group of projectile points which exhibits a range of morphological variability intermediate between the Fairland and Ensor types as they have been defined and utilized previously. Based on the original definitions of Fairland and Ensor types, this group of specimens clearly resembles the Fairland type more closely. Unfortunately, there has been little consistency among researchers within Central Texas regarding the utilization of these type names. Analyzing the artifacts from the Oblate Site (41CM1), Curtis Tunnell classified a similar range of morphological variability within three varieties (D,E,F) of the Ensor type (Johnson, Suhm, and Tunnell 1962:88-90). Suhm, on the other hand, when analyzing specimens from the Footbridge Site (41CM2), apparently chose to follow the original type definitions more closely and to use the term, Fairland, even though she recognized the similarities to Ensor, Variety E, as described by Tunnell (Johnson, Suhm, and Tunnell 1962:60-61). The use of these terms continues to the present. Unfortunately, many investigators have become overly obsessed with the ability to "pigeonhole" particular specimens and consequently have tended to ignore the total range of variability exhibited and what its significance might be.

It is not our intention in this report to resolve the issue of whether this range of variability is more correctly subsumed under the designation of the Fairland or Ensor type; rather, our intention is to merely document or acknowledge a limited, arbitrary slice of the continuum of morphological variability. An understanding of the cultural significance of this variability within the temporal and spatial dimensions of Central Texas prehistory is, indeed, a desired objective; however, the present sample alone, is not an adequate data base for such an endeavor.

The 68 specimens, most of which are fragmentary, were found at sites in both the Granger and North Fork Reservoirs. A disproportionate number, however, were recovered from only two sites, 41WM53 (15 specimens) and 41WM56 (34 specimens), in the North Fork Reservoir. Elsewhere in the North Fork Reservoir a total of 11 Fairland/Ensor specimens were recovered from sites 41WM57 (4) and 41WM323 (7). In the Granger Reservoir sites 41WM124 (4 specimens), 41WM267 (2 specimens), 41WM163 (1 specimen), and 41WM258 (1 specimen) yielded a total of 8 specimens.

The blade morphology of this sample is quite homogeneous. The broad blades have straight or slightly convex edges. Beveling of the blades is not represented in this sample. The blade-stem transition, unlike the Fairland type as it was originally defined, is marked by barbed shoulders on most specimens. The stems of this sample exhibit more variability. Some of the stems are formed by long, shallow notches as Suhm, Krieger, and Jelks originally noted in 1954. Other specimens have deeper and more constricted notches. These specimens which also lack pronounced barbs approach the "Ensor" portion of the morphological continuum. All stem edges are finely retouched. The base shape is usually concave, although some specimens have straight bases.

It is the stem variability of these points that has caused classification problems. This sample from the Granger and North Fork Reservoirs admittedly contains a wide range of variability. Unfortunately, not enough of these fragmentary specimens were removed from dated contexts which might provide a temporal framework for this variability. The only spatial variability that is evident within this sample is that these points were apparently utilized and discarded more frequently within the North Fork Reservoir. The significant difference in numbers however, may indicate that social or functional differences in the utilization of the two areas were important factors affecting the spatial distribution of these specimens during the Twin Sisters Phase.

Hoxie

Hoxie (11 specimens, Figure 14.1-2h-j): This projectile point type was originally defined in the Rogers Springs site report (Prewitt 1976b). Once again, only two sites yielded these eleven specimens. Eight were recovered from the Cervenka Site (41WM267); three were removed from the Hawes Site (41WM56). While these specimens share several characteristics, the variability of the stem shape is quite noticeable. Five of the specimens (Cervenka-3; Hawes-2) exhibit flared or expanding stems with concave edges and straight or slightly concave bases. Stem edges are ground on two of these. Shoulders are weak to strong. The remaining six specimens have a straight edged, rectangular stem. Beveling of the stem edges is also common. Basal edges vary from slightly convex to slightly concave. One stem which has been basally thinned has the wedge shape of the later Bulverde point. Shoulders in

this group are more prominent; two specimens have prominent barbs.

The blades of these eleven specimens share two prominent characteristics: beveling and serrated edges. Only two specimens from the Cervenka Site lack either beveled or serrated edges. One specimen from the Hawes Site lacks both of these characteristics. Splitters would definitely label these points as Hoxie-like. The presently unknown range of variability for this type, however, should cause investigators to avoid a proliferation of terminology at this time. The remaining specimens exhibit either alternate beveling (usually the left edges) or single edge beveling (left edge). The angle of the bevel varies significantly among these specimens.

The context of these specimens is consistently that of the late San Geronimo or early Clear Fork components in both sites (Table 7.1-1). At the Cervenka Site the Hoxie points are consistently deeper than the Dawson points and Groups 1 through 5. At both sites the few Wells points are found beneath the Hoxie points.

Uvalde

Uvalde (3 specimens; Figure 14.1-3a,b): Two of the points which comprise this category are from excavation unit D of the Cervenka Site. The other is from the Hawes Site. Although the general form of all three specimens is similar, the Cervenka specimens display different retouch techniques. The blades of both specimens are finely serrated. The appearance of the blades alone bears a strong resemblance to the Hoxie points. The stems, however, exhibit concave edges and flare outward at the base. Both bases are concave in shape. The stem of the smaller specimen has been flaked so that its transverse plane is not the same as that of the blade. Consequently, the point has a twisted appearance.

The specimen from the Hawes Site has a similar stem except that one edge is recurved rather than concave in shape. The stem is also oriented differently in that its longitudinal axis is oblique to the longitudinal axis of the blade. The blade of this specimen is more irregular than those from the Cervenka Site.

All of these specimens were recovered from a San Geronimo component. The Hoxie points are immediately above them. At least within the Granger Reservoir area, the serration of blade edges was apparently a common stylistic feature during the latter portion of the San Geronimo Phase.

Wells

Wells (2 specimens; Figure 14.1-3c,d): Both of the specimens of this category were recovered from excavation unit D of the Cervenka Site. The blades of both specimens are finely retouched and exhibit

serrated edges. Shoulders are either weak or barbed. The stems of both specimens are long and narrow with parallel contracting edges. The stem edges are ground slightly. The base of the stem of the larger specimen is unmodified and has cortex as the Dawson specimens do. The base of the other specimen is finely retouched.

Both of these specimens were recovered from the deeper portion of the San Geronimo component of the Cervenka Site. "Tortugas" points are stratigraphically associated. Uvalde and Hoxie projectile points are found above these specimens. Only a Group 12 specimen was recovered deeper within excavation unit D (Table 7.1-1).

Summary and Conclusions

The triangular and stemmed projectile points discussed in this section have varying degrees of similarity to previously defined types. As expected, the variability of specimens within a given projectile point type is often great in Central Texas. An attempt to accurately describe this variability in the San Gabriel assemblages was made; nevertheless, the significance of such variability continues to be elusive. The San Gabriel assemblages, however, provided important contextual information which will eventually aid on understanding of projectile point variability. Since this data base represents only a small portion of the San Gabriel River valley, the proposal of new type variety designations was avoided.

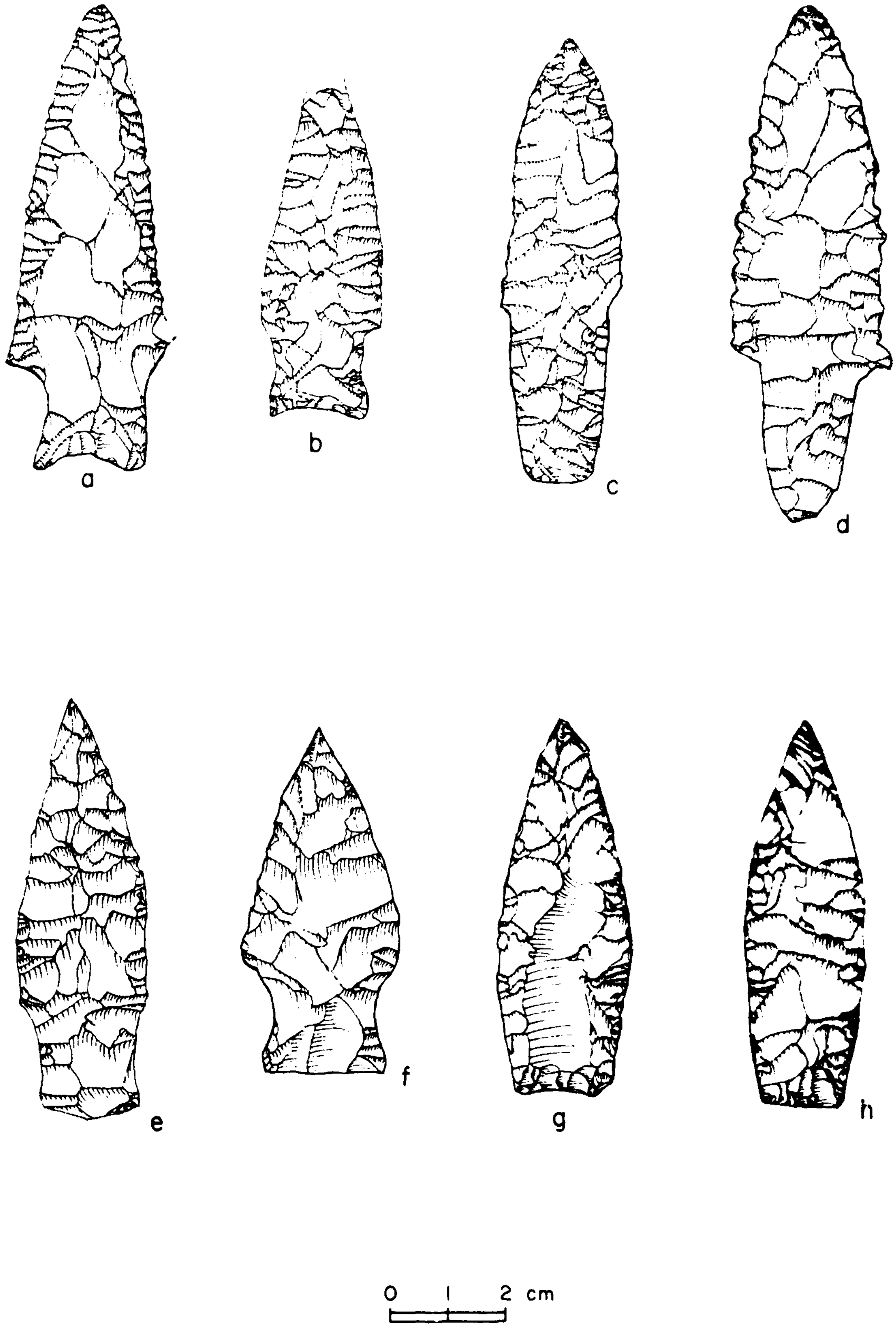
Simple triangular projectile point forms are relatively rare throughout the prehistoric utilization of the San Gabriel River valley. Only two types of triangular points, representing very separate and distinct periods of occupation, were recovered. The "Tortugas" specimens are a product of the occupations of the Clear Fork and San Geronimo stratigraphic units (4,000-7,000 B.P.). The small Fresno points, on the other hand, represent a late Toyah Phase occupation (post-650 B.P.) on the North Fork drainage. The distinctive morphological characteristics and stratigraphic contexts of these triangular specimens renders them very useful as temporal indicators in a general sense (i.e., Early Archaic, Late Neo-American). Finished triangular bifaces are not a common element of the assemblages of the intervening components.

Whether both types actually functioned as projectiles is open to question. The small, delicate Fresno specimens likely served as arrow tips; however, the more massive "Tortugas" specimens may have served as knives rather than as dart points. Such a proposition is quite plausible when one considers that the Early Archaic assemblages contain numerous other stemmed dart points. The relatively low number of "Tortugas" specimens within an assemblage suggests that they may have been more valued possessions which were curated for longer periods of time. The resharpening of a blade used as a knife would have greatly prolonged its use-life and also produced a beveled cutting edge. Detailed use-wear analysis of the edges of the "Tortugas" specimens is essential to the testing of this proposition.

FIGURE 14.1-3

STONE TOOLS: PROJECTILE POINTS.

	Site	Type
a	41WM267	Uvalde.
b	41WM267	Uvalde.
c	41WM267	Wells.
d	41WM267	Wells.
e	41WM267	Group 1.
f	41WM56	Group 2.
g	41WM267	Group 3 (Angostura.).
h	41WM267	Group 3 (Angostura.).



14.1-3

The amount of morphological variability of these two types also varies significantly. This is not unexpected since the Fresno specimens are the products of behavior within a much more constricted time span than that of the "Tortugas" specimens. The considerable variability of the "Tortugas" specimens in Central Texas is adequately described, both in previous reports (Sorrow 1969; Sorrow et al. 1967) and in this chapter, so that other researchers may easily recognize the clusters within this variability. As stated earlier, the term, "Tortugas," as applied to specimens from many areas and temporal periods of Texas prehistory, is considered inappropriate for these specimens. However, the proposal of a new type name at this point in time would serve no useful purpose. Reference to the three descriptive categories, Groups I-III, presented within this chapter or Sorrow's (1969) descriptive categories should allow for more than adequate communication among researchers in Central Texas.

The discussion of the stemmed projectile points emphasized the variability present within a recognized type. A great amount of variability is especially notable among the "Dawson" and "Fairland/Ensor" specimens. Unfortunately, the arbitrary assignment of new type or variety names to these specimens will not contribute significantly to our understanding of the cultural implications of such variability. Such an understanding will come about only when the variability is examined in relation to cultural context.

The San Gabriel assemblages have provided much needed contextual information for most of the stemmed projectile point styles discussed here. This is especially true for those specimens associated with presumed Early Archaic assemblages. Although the Andice, Dawson, Hoxie, Uvalde, and Wells point forms have been previously recovered from Central Texas sites, their temporal context has been estimated on the basis of relative stratigraphic position only. The recovery of radiocarbon samples from the Cervenka Site (41WM267) in stratigraphic association with these point forms provides a more absolute time frame for the Early Archaic period. The Wells, Tortugas, and Uvalde forms appear earliest in the sequence around 5500 B.P. (Table 7.1-1). Hoxie points were stratigraphically higher in association with a hearth which provided a corrected date of 4970 $\pm$ 436 B.P. After 5,000 B.P. the projectile point styles change dramatically with the appearance of Dawson points and other previously undefined forms (Table 7.1-1).

The projectile point forms utilized prior to 5000 B.P. are distinguished by flaring stems and massive blades which are commonly beveled and frequently exhibit serrated edges. Although sampling bias may be a problem, these projectile point forms appear to be more common to the Blackland Prairie region. After 5000 B.P. the projectile point forms become less distinctive. Diminutive triangular blades and weak shoulders are common. Beveling of the blade and serration are still present, but they occur less frequently. This shift in projectile point styles together with the more intensive exploitation of the San Gabriel River valley provides the basis for the recognition of the San Geronimo and Clear Fork Phases of the Early Archaic period.

Previously Undefined Projectile Point Groups

The variability of many of the specimens recovered from the San Gabriel assemblages is outside the range of variability of the types previously defined in the literature. Since the spatial and temporal distribution of these specimens is relatively unknown outside the North Fork and Granger Reservoir areas, no type designations are proposed. Arbitrary descriptive category designations (Group 1, 2, etc.) are presented instead. The grouping of such specimens is based upon overall similarity of morphology and the presence or absence of distinctive modifications such as beveling, serration, and grinding. Similarities to specimens previously described in the literature are noted.

Group 1

Group 1 (8 specimens; Figure 14.1-3e): Eight specimens from the Cervenka Site (41WM267) comprise this category. The most distinctive characteristic of this category is the beveling of the left edge of the blade. Two specimens exhibit alternate beveling of the left edges. The beveling is usually confined to the distal two-thirds of the blade. The blades uniformly show a lack of bilateral symmetry. Shoulders are very weak. Stem edges are straight to slightly concave; bases are straight to slightly convex. The stems of four specimens have been basally thinned. None of the stem edges have been ground.

Six of these points were recovered from controlled excavation units B and D at the Cervenka Site (Table 8.10-1). Five specimens were recovered within the Clear Fork culture/time stratigraphic unit. The one remaining specimen is deeper within the San Geronimo component. Radiocarbon dates from Area D (Table 7.1-1) document that this form of projectile point was utilized prior to 4900 B.P., but was most common at the Cervenka Site shortly after 4900 B.P.

Group 2

Group 2 (10 specimens; Figure 14.1-3f): This category is comprised of six specimens from the Cervenka Site (41WM267). In the North Fork Reservoir, one specimen from 41WM73 and three specimens from the Hawes Site (41WM56) occur. The blade morphology of these specimens varies considerably. The larger size of the North Fork Reservoir specimens may be related to raw material availability. Although all specimens display secondary retouch, many of them lack good dorsal-ventral symmetry. The characteristics common to all specimens within this group are the moderate to strong shoulders, the concave stem edges, and straight to slightly convex stem bases. Some of the stems have also been basally thinned. Although stem size is quite variable, these common characteristics produce a consistent "flared" or "slightly expanding" stem.

At the Cervenka Site (41WM267) these specimens are clearly associated with the early Clear Fork components (Table 8.10-1). The association of one specimen with Feature 9 places its utilization as early as 4900 B.P. At sites 41WM56 and 41WM73 the Group 2 specimens are also within a Clear Fork stratigraphic unit. Within Area C of site 41WM56 one specimen is stratigraphically associated with a radiocarbon date of 3615 ± 60 B.P. (UGa-2485). The deeper specimen is one level below Feature 14b which yielded a date of 3750 ± 90 B.P. (UGa-2473). Once these dates are dendrochronologically calibrated (Table 6.1-1) it is apparent that this projectile point style was present during at least the latter half of the fifth millenium B.P. at site 41WM56. The associated radiocarbon date with the specimen at site 41WM73 places this point style even earlier; however, the large sigma value (± 725 years) associated with the date (5285 B.P.) raises some questions concerning its reliability. Nevertheless, a fifth millenium B.P. date, or earlier, is still likely when a confidence interval of two sigma is used with the corrected date (6090 ± 736 B.P.).

Group 3

Group 3 (4 specimens; Figure 14.1-3g,h) These projectile points were all recovered from the Cervenka Site (41WM267). Two were found in the backdirt of backhoe trench 3A. The remaining two specimens were recovered from excavation units A and B. For all practical purposes these projectile points fall within the Angostura type as defined by Suhm and Jelks (1962:167-168). All have a narrow leaf shape with a slight shoulder and lightly ground stem edges. Their context, however, is somewhat unexpected, for both specimens from controlled excavation units were recovered within the Clear Fork component. Prewitt (1976a) has previously designated the Angostura point as one of the "fossil indexes: of the earlier Circleville Phase (7000-8000 B.P.)." Apparently, this point style continued to be utilized for some time. The presence of an Angostura point, therefore, does not necessarily indicate a Paleo-Indian/Archaic transitional context. Elsewhere in the Granger Reservoir at the Loeve Site (41WM133), Angostura points have been recovered within an earlier context. Two specimens were associated with a hearth which provided a date of 8500 ± 130 B.P. (Tx-2675).

Group 4

Group 4 (30 specimens; Figure 14.1-4a,b): This group of projectile points contains a significant amount of size variability. Nevertheless, all possess a rectangular stem with straight edges and straight-to-slightly-convex bases. Six stems exhibit basal thinning. The blade-stem transition is accented by a weak to moderately strong shoulder. The narrow blade has straight to slightly convex edges. Although the stems bear some resemblance to the Bulverde type, these points lack the strong shoulders and breadth of blade that is

characteristic of that type.

The context of the majority of the twenty-three specimens recovered at the Cervenka Site (41WM267) is that of a Clear Fork Phase occupation. Two of the specimens, one each from excavation area A and G, respectively, were recovered from a late Archaic context. The two specimens from Site 41WM73 are from an early Round Rock component. The remaining five specimens from site 41WM56 further cloud the temporal association of this group, since four different contexts (San Marcos, Round Rock, Clear Fork, and San Geronimo) are represented. From the perspective of both reservoirs the value of this group as a temporal index is highly suspect. However, the predominance of this projectile point style within the Clear Fork component of the Cervenka Site indicates a special relationship to the Blackland Prairie environment. Whether the distribution of this projectile point style represents a cultural or adaptational difference between the Edwards Plateau and the Blackland Prairie remains to be determined. The number of excavated Clear Fork assemblages is small within either environmental zone.

Group 5

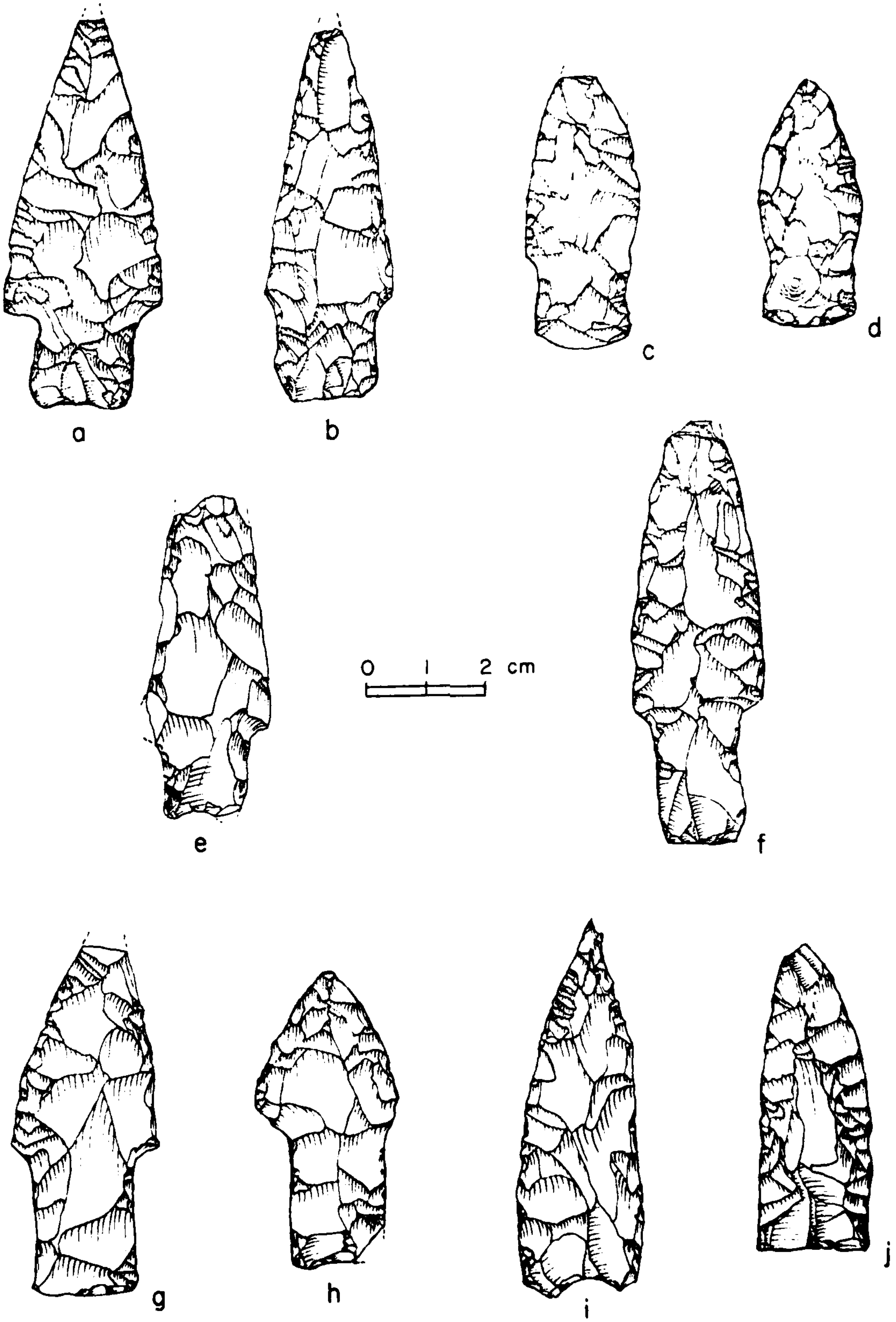
Group 5 (9 specimens; Fig. 14.1-4c-d): This group of projectile points is represented at only two sites, Cervenka (41WM267) and the Hawes Site (41WM56). All nine specimens are fairly small in size. The narrow blades have convex edges. Secondary retouch is usually inconsistent or totally lacking. The blade-stem transition is marked by either weak shoulders or the mere constriction of the blade. The characteristic flaring stem exhibits a convex base.

The context of six of the seven specimens recovered at the Cervenka site is clearly that of the Clear Fork component (Table 8.10-1) The one remaining specimen is in a San Marcos Phase context. The two examples from the Hawes Site were recovered from a Clear Fork and San Geronimo component, respectively. The primary temporal association of this projectile point form within the San Gabriel drainage, therefore, is the Clear Fork Phase. Elsewhere at the Landslide Site (41BL85) a similar form of projectile point (Specimen H, Fig. 15) has been recovered in Occupational Phase 3, a San Geronimo component (Sorrow, Shafer, and Ross 1967:23-24, 41-42). Shafer somewhat mistakenly notes the similarity between Specimen H and Sorrow's Group 12 (Sorrow, Shafer, and Ross 1967:79-82) at the Evoe Terrace Site (41BL104). Sorrow's Group 13 (pp. 30-82) is clearly closer in form to the above mentioned points. The context is once again that of the San Geronimo component. Although this projectile point form is not well represented at any of these four sites, it is consistently found associated with other recognized diagnostic artifacts of the Early Archaic periods. Unfortunately, their spatial distribution is almost entirely unknown beyond these four sites.

FIGURE 14.1-4

STONE TOOLS: PROJECTILE POINTS.

	Site	Type
a	41WM73	Group 4.
b	41WM267	Group 4.
c	41WM267	Group 5.
d	41WM56	Group 5.
e	41WM267	Group 6.
f	41WM56	Group 7.
g	41WM267	Group 8.
h	41WM267	Group 8.
i	41WM56	Group 9.
j	41WM267	Group 9.



14.1-4

Group 6

Group 6 (2 specimens; Figure 14.1-4e): These two specimens from the Cervenka Site (41WM267) may be variants of the Pedernales type. Both fragmentary specimens have narrow stems with a U-shaped basal notch. The more complete specimen has a long, narrow blade with straight to slightly convex edges. Weak to moderate shoulders comprise the blade-stem transition.

The context of these two specimens within excavation units A and B of 41WM267 (Table 8.10-1)is that of Clear Fork/Round Rock transition levels. A variant of the Pedernales type would not be unexpected in such a context. This form was not found anywhere in the North Fork Reservoir where Round Rock Phase assemblages are much better represented (or at least more visible).

Group 7

Group 7 (14 specimens; Figure 14.1-4f): This category again is represented only at the Cervenka Site (10 specimens), the Hawes Site (3 specimens), and site 41WM73 (1 specimen). The group is characterized by a narrow, rectangular stem. In two instances the stem becomes more narrow toward its proximal end. Stem bases are straight except for two specimens shich have convex bases. Three stems have been basally thinned. The blade-stem transition is either strong shouldered or barbed. Blades are fairly massive with convex edges.

The specimens from sites 41WM73 and 41WM56 are clearly associated with a Clear Fork component. The more commonly recognized fossil indexes of this phase (the Bulverde, Nolan, and Travis points) are stratigraphically associated. Interestingly, the Clear Fork component at the Cervenka Site does not contain these familiar fossil indexes in such abundance. Unfortunately, the present radiocarbon dates do not allow one to rule out diachronic variability as a source of this inter-site difference. Six of the above described points comprise a minor portion of the Clear Fork assemblage at the Cervenka Site. The remaining three specimens were recovered from a Middle to Late Archaic context (Table 8.10-1).

Group 8

Group 8 (2 specimens; Figure 14.1-4g,h): These two specimens were both recovered from the Cervenka Site (41WM267). Only one was recovered during controlled excavation of Area B; the other was collected from the ridge bordering the site. The most noticeable characteristic of either point is the long, rectangular stem. The stem comprises from one-third to one-half of the total length of each specimen. One stem edge of each specimen is slightly ground. Stem bases are straight. Shoulders are weak to prominent.

The stem length of the surface collected specimen is accented by the short, assymetrical blade. The shortness of the blade is likely due to the reworking of the blade edge. This reworking takes the form of alternate beveling of the left edges. The blade of the remaining specimen is also assymetrical, but no beveling is present. The assymetrical form of the blades, however, may indicate that both specimens were utilized as knives rather than as projectile points. Future microwear studies are needed to resolve such issues.

Since the one specimen was recovered in a Clear Fork component many archaeologists would probably categorize these specimens as Bulverde-like. Unfortunately, such a category is becoming increasingly unwieldy. Presently, the distinctive form of these two-specimens distinguishes them suffieiently to warrant stylistic consideration outside the catch-all category of "Bulverde-like". Whether or not the spatial or temporal distribution of this projectile point form will ever justify a type designation remains to be seen. In the meantime, one should avoid all-inclusive categories which contain more variability than that exhibited between categories. Our dependence upon the projectile points for chronological control has often biased our perception of morphological variability. Specimens tend to look alike because they "need" to be similar for chronological control; the behavioral patterns reflected by this variability are too often ignored or viewed as unsubstantiated speculation.

Group 9

Group 9 (5 specimens, Figure 14.1-4i,j): This somewhat heterogeneous category shares a shoulderless triangular form. The haft area is delineated by either ground edges (2 specimens) or a very shallow side notches (2 specimens). The haft area of the remaining specimen is presumably accented by the slightly greater width of the proximal portion of the blade. The bases of these specimens are either straight (2) or concave (3). The specimen having the greatest basal concavity (Figure 14.1-4i) once possessed projecting basal corners. Due to these features some resemblance to the Gower-like points (Sorrow, Shafer, and Ross 1967:16-18) recovered from the Landslide Site (41BL85) in Stillhouse Hollow Reservoir is evident. Unlike the Gower-like points, however, the basal concavity of this specimen has not been unifacially chipped.

The blades of these specimens have straight to convex edges. The edges of three of the blades are also sharply beveled. Alternate beveling of the left edges is characteristic of two specimens; the right edges of the third specimen are beveled.

Only three of the five specimens were recovered from a controlled provenience at the Cervenka Site. Two of these are from the San Geronimo component within excavation area D (Table 8.10-1). They are stratigraphically associated with the Hoxie points and lie

immediately above the Uvalde points. The third specimen, although in excavation unit A, is also associated with Hoxie points.

Group 10

Group 10 (4 specimens; Figure 14.1-5a,b): Three of these specimens are from the Cervenka Site; one is from the Hawes Site. The characteristics which these specimens have in common are found in the shoulder and stem areas. All four specimens have flared or expanding stems with concave edges formed by generally shallow side notches. Stem edges are ground on two specimens. Three of the stems have straight bases while the fourth has a convex base. Shoulders are weak to moderately strong.

The stems of these points are morphologically very similar to those of the Hoxie points. However, the blades of these specimens show neither the beveling nor the serration that is characteristic of the Hoxie points. Nonetheless, the context of these points, except for one (Table 7.1-1), is consistent with that of the Hoxie points (San Geronimo component). The one exception is found in a San Marcos Phase context. The overall contemporaneity and general morphological similarity of these two categories suggests that the Hoxie point may be a more complex variant of this general projectile point form.

Group 11

Group 11 (2 specimens; Fig. 14.1-5c): Both of these specimens have long, narrow blades with convex edges. Since the blade merely narrows near the proximal end and expands again at the base, shoulders are non-existent on both specimens. The blade of the one specimen (Fig. 14.1-5c) exhibits a "twist" similar to that of the Pandale points (Suhm and Jelks 1962:231-232).

Both of these points (one from the Cervenka Site; the other from the Hawes Site) were recovered from a Clear Fork component. Once again, the basal flaring of the stem appears to be a consistent characteristic of this early Archaic period.

Group 12

Group 12 (2 specimens; Figure 14.1-5d): These two specimens represent the earliest points found at the Cervenka Site and site 41WM57, respectively. Although the specimen from site 41WM57 is fragmentary, the stem and shoulder characteristics are very similar to the Cervenka specimen. The stem is formed by broad side notches. As a result of this technique, strong shoulders and a flaring or expanding stem are produced. Both specimens are symmetrical in outline. The base of each stem is straight. The blade of the complete specimen exhibits convex

edges with a very slight bevel of the right edge.

Although this particular morphology is not presently recognized as a temporal index of the San Geronimo Phase, it is apparent that the flaring or expanding stem is a characteristic trait of the Cervenka assemblage. The stems of some of the Hoxie points and the Group 10 specimens are of the same style. The Group 2 specimens, which are more common within the Clear Fork components, also exhibit a similar stem morphology; the depth of their notches is merely not as great.

Group 13

Group 13 (3 specimens; Fig. 14.1-5e,f): Two of these specimens were recovered from the Hawes Site; the third is from the Cervenka Site. All three specimens have been rather crudely knapped. The sinuous blade edges are generally convex in form. Shoulders are very slight since the stem is formed by broad, shallow side notches. The stem edges of both specimens from the Hawes Site are lightly ground. All three bases are concave. The basal corners, if unbroken, are rounded.

Only the two points from the Hawes Site were recovered from a controlled excavation unit. Both of these points were within a San Geronimo component. The one specimen from excavation unit C was stratigraphically associated with a Martindale point. These points share several morphological characteristics with the Gower-like specimens recovered from the Landslide Site (41BL85) (Sorrow, Shafer, and Ross 1967:16-18). The indented bases of these specimens, however, have not been unifacially chipped.

Group 14

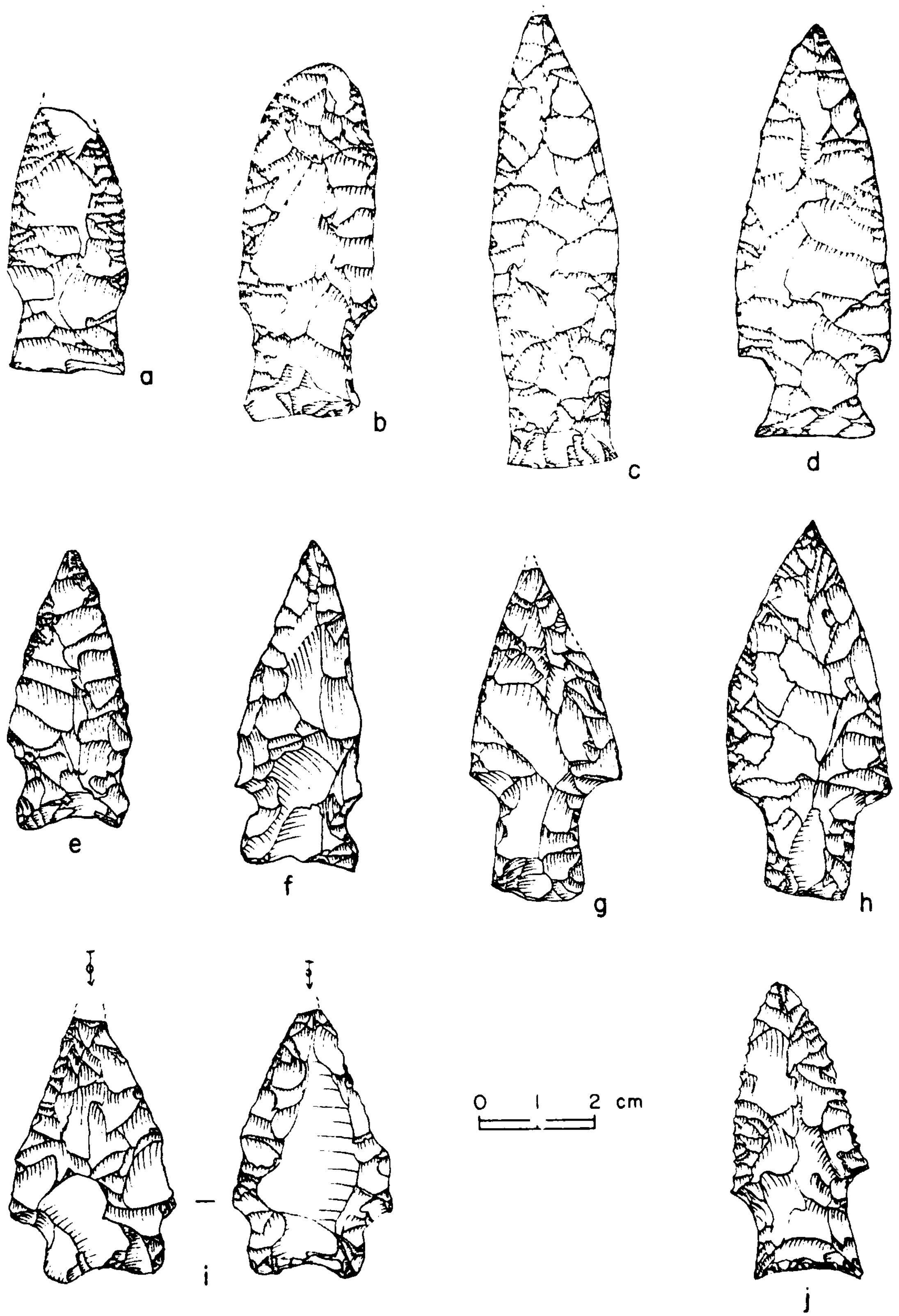
Group 14 (14 specimens; Figure 14.1-5g,h): This group consists entirely of specimens recovered from sites within the North Fork Reservoir. Eleven specimens are from the Hawes Site; two are from site 41WM304; and one is from site 41WM73. Although this group is a rather heterogeneous lot, they share the following characteristics: (1) rather massive triangular blades; (2) strong or barbed shoulders; and (3) robust, rectangular stems. The stem bases are either straight or slightly convex. In some cases basal thinning of the stem has produced a wedge-like shape that is associated with the Bulverde point.

Previous investigators have traditionally placed such specimens within the all-inclusive category of "Bulverde-like" (Sorrow, Shafer and Ross 1967). Most of these specimens were recovered from a Clear Fork component. Only one was associated with Round Rock Phase artifacts. The Clear Fork Phase is the expected association for specimens which share some of the morphological characteristics of the Bulverde type.

FIGURE 14.1-5

STONE TOOLS: PROJECTILE POINTS.

	Site	Type
a	41WM56	Group 10.
b	41WM267	Group 10.
c	41WM267	Group 11.
d	41WM267	Group 12.
e	41WM56	Group 13.
f	41WM267	Group 13.
g	41WM56	Group 14.
h	41WM73	Group 14.
i	41WM267	Specimen A, dorsal and ventral view.
j	41WM267	Specimen B.



14.1-5

Specimen A

Specimen A (Figure 14.1-5i): This crudely chipped specimen resembles a previously illustrated variant of the Gower point (Shafer 1963:64-65, 72). Although there is a significant amount of variability within this type class as it is presently used, all specimens are from an early San Geronimo Phase context. Unfortunately, this specimen from the Cervenka Site was recovered from the backdirt of a backhoe trench.

This specimen was produced from a flake blank. The ventral surface has been only partially altered. The shoulders, unlike those of most Gower points, are quite prominent. The stem edges are slightly recurved; the basal edge has been bifacially worked to produce a concave indentation. The lack of complete bifacial retouch has resulted in a very assymmetrical projectile.

Specimen B

Specimen B (Figure 14.1-5j): This single specimen is from the Clear Fork component at the Cervenka Site (Area D). The relatively small, triangular blade has convex edges. Beveling is present on the proximal portion of the alternate left edges. The distal portion of one right edge is also beveled. The consistent secondary retouch of both edges has produced a serrated effect. The blade-stem transition is marked by moderately strong shoulders. The parallel stem edges expand slightly toward the base. Both stem edges are lightly ground. The stem base is concave.

Various characteristics of this specimen, i.e., the beveling, serration, and expanding stem, are also prominent within some of the other recognized groups (Hoxie, Group 10, Group 2). However, this specimen does not appear to be a variant of any one of these groups; rather, it possesses a combination of these groups' characteristics. Interestingly, these same characteristics appear much later in time on the Darl points of the Twin Sisters Phase. The context of this particular specimen is clearly that of the Clear Fork component. Nevertheless, if it had been found on the surface of a site, it is doubtful that it would have been recognized as an early Archaic projectile point.

Summary and Conclusions

It is noteworthy that most of the specimens comprising these descriptive categories were recovered from the Blackland Prairie region. The Clear Fork and San Geronimo components from the Cervenka Site (41WM267) account for almost all of the specimens. Projectile points with flaring stems and blades which have beveled and serrated edges are apparently characteristic of assemblages in the Blackland Prairie region. Since the traditional diagnostic artifacts of the Early Archaic period of the Edwards Plateau region are not well represented at the Cervenka Site, it appears that social interaction between the two regions may have been limited. However, given the limited sampling of Early Archaic assemblages within the Blackland Prairie region, the postulated distinctiveness of the Blackland Prairie adaptation must be verified through future research.

14.2 An Experiment in the Assessment of Projectile Point Variability

by

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Introduction

From the previous discussion of the traditional formal categories (Chap. 14.1), it is apparent that there is much confusion regarding the classification of the morphological variability of the projectile points of Central Texas. Indeed, a superficial examination of the Handbook (Suhm and Jelks 1962) will indicate that the variability displayed by a given type is frequently as great as that exhibited between some types. As Robert Dunnell points out in Systematics in Prehistory (1971:139-140), much of the non-replicability associated with the use of classification and classes such as these results directly from the problem that no true classification has been presented even though one has obviously been employed. Definitions, as necessary and sufficient conditions for membership in a class, are not separated from the descriptions of a particular set of specimens assigned to a specific class. In other words, one cannot differentiate those attributes which an artifact assigned to a given type "must" display from those attributes which an artifact "may" display. Consequently, the classification of projectile points has been a subjective procedure based upon intuitively discerned morphological attributes.

This intuitive property of the traditional projectile point classification schemes allows each investigator to select his or her own criteria for inclusion in a given type. The result is a wide range of variability of artifacts included in a defined type. Furthermore, due to the limits of the human mind, the number of attributes that can be used simultaneously for grouping is very small when compared to those analyzed by more objective criteria (Sackett 1968:73). As Service (1964:372) has commented, any investigator is apt to select, consciously or unconsciously, a small subset of attributes as a basis for classification. For example, classification of projectile points in Texas has concentrated on characteristics related to the stem and methods of notching. Intuitive typologies also utilize sorting procedures which do not account for the subtle variation that occurs in the few attributes that are designated for analysis.

Due to these inherent problems with an intuitive typology, the multi-dimensional nature of projectile point variability has been largely overlooked. The variability may reflect changes in the behavioral subsystems, such as artifact function, manufacturing techniques, and patterns of symbol recognition or social interaction. Due to the likely interaction of these subsystems, an understanding of the significance of such variability is not easily attained. In order for such an understanding to be reached, however, an objective assessment of the variability exhibited by a sample of projectile points must be accomplished first. Only a few researchers (Benfer 1967; Gunn and Prewitt 1975) have attempted a more structured analysis of projectile point variability in Central Texas. These researchers, along with others (Montet-White 1973, Thomas 1970, Christenson and Read 1977, Jefferies 1978) have relied upon multivariate analytical techniques to objectively assess such variability. Unfortunately, the applicability of the multivariate techniques to the problem of assessing projectile point variability has not always been adequately considered. It is, therefore, the purpose of this chapter to explore the potential and limitations of multivariate analytical techniques in objectively assessing projectile point variability. The adequacies or inadequacies of the traditional formal typology also will be evaluated in relation to this assessment.

Methodological Evaluation

Providing a more objective method for artifact classification has been the goal of various archaeologists such as Spaulding (1953), Sackett (1966), Thomas (1970), Montet-White (1973, 1974), Gunn and Prewitt (1975), and Christenson and Read (1977). While these investigators have realized that all classification schemes are based on types containing a continuum of attribute variability, they have also realized that it may be possible to reduce intra-group variability by utilizing more meaningful attributes derived through multivariate analysis (Jefferies: 1978:98-99). Unfortunately, there has been little agreement concerning the appropriate variables to be utilized and much confusion regarding the applicability of various multivariate statistical techniques to such problems.

The determination of which set of discrete measurements will best characterize the outline of a tool has been considered a primary problem by some researchers (Montet-White 1973; Jefferies 1978). Most researchers (Benfer 1967; Thomas 1970; Gunn and Prewitt 1975) have utilized linear and angular measurements of projectile points as attributes. Montet-White (1974) and Jefferies (1978), however, view the use of polar coordinate measurements as a more effective technique when analysis is concerned with the functional and formal properties of an

industry (Montet-White 1974:21-22). This technique does have immediate appeal, for the method is intended to minimize the loss of information when the outline of an irregular geometric form is transformed into discrete measurements compatible with statistical analysis (Montet-White 1974:18). However, Montet-White's (1974:21-22) only apparent justification for this measuring technique over the more traditional techniques was that statistical tests, whenever applied to polar coordinate points, produced replicable and predictable results. Contrary to Montet-White's (1974:21) claims, the success of the principal component analysis in extracting a number of properties which characterize the technological and formal aspects of the points is not necessarily dependent upon her measurement technique. Our own research has demonstrated that principal component analysis of linear and angular measurements will also typically produce components that relate first to overall blade size and then to stem shape and size. The very neat correspondence between the major portions of the projectile point and the sequence of technological operations may very well be an artifical construct of the principal component analysis. Therefore, Montet-White's conclusions that the morphological variability of the projectile point sample can be related to sequential events in the manufacturing process are highly suspect, even though her systemic model of point manufacture and use is an enlightened and useful approach.

Other researchers who have relied upon the more traditional linear-angular measurements of morphological variability have not been explicit in justifying their choice of attributes. Although it is not usually stated, the inability of the analyst to predetermine the relevance of a given attribute renders such archaeological research exploratory in nature. Perhaps, Benfer (1967:720) states the situation best:

> As for the particular characteristics chosen, I sought to include characteristics previously suspected of having cultural variability and also to include other characteristics that might enhance the serendipity effect of factor analysis. Inclusion of characteristics that might be trivial could not harm the factor analysis, and some might lead to the discovery of new important dimensions of the projectile points.

The exploratory nature of such research reflects our general lack of knowledge concerning the relationship of functional and technological factors to morphological variability. Until more sophisticated models of bifacial production and utilization are developed, analysts will continue to rely on "serendipity" to discover new artifact dimensions. Presently no single set of discrete measurements can be viewed as best characterizing artifact morphological variability.

Several multivariate techniques (factor analysis, principal component analysis, numerical taxonomy, and discriminant analysis) have been utilized to reduce artifact variability to a smaller set of dimensions.

Quite frequently the analysis has involved data reduction techniques which yield numerically generated typologies. Unfortunately, many analysts have failed to determine if the concepts underlying a particular multivariate technique are appropriate for archaeological data and the general aims of archaeological classification. As Christenson and Read (1977:163) point out, there has been a failure in the process of accepting statistical classification techniques to present convincing arguments of their relevance.

The immediate goal of many analysts is to test or validate the extant, intuitive classification systems for a projectile point collection. Discriminant analysis, which can test the success of discriminating variables in distinguishing groups or can serve as a classification technique, has been used for this purpose. Luchterhand (1970:18-24) utilized direct discriminant analysis to test the effectiveness of 17 linear-angular measurements in discriminating five subjectively determined types in a sample of Archaic projectile points from the Lower Illinois valley. Gunn and Prewitt (1975:139-149), on the other hand, used stepwise discriminant analysis as an automatic classification device for projectile points from southwest Texas. One noticeable problem with such an approach is that the original sample groups in Luchterhand's case are so homogeneous that one would not expect the discriminant analysis to suggest new groupings. Gunn and Prewitt (1975:140) likewise created more homogeneous type groups by removing points from the original type list. Their reasoning was the points "were aberrant enough that they fell within the range of variation of other types and had to be eliminated" (1975:140). Gunn and Prewitt may have succeeded in achieving some consistency in classification, but no greater objectivity. Discriminant analysis, therefore, provides a mathematical basis for intuitive typologies. No new information is provided, for no assessment of the interaction or covariation of attribute variability is made.

The most widely discussed technique for archaeological classification is numerical taxonomy or cluster analysis (Sokal and Sneath 1963, Clark 1968, Thomas 1972, Doran and Hodson 1975, Christenson and Read 1977, Jefferies 1978). There is apparently wide acceptance of this technique as an aid to archaeological classification, even though there is little agreement as to how it is to be utilized. Clarke, Thomas, Doran, Hodson, and others have advocated the use of cluster analysis on raw data as a procedure for archaeological classification. Christenson and Read (1977:174), however, have questioned the appropriateness of the underlying concepts of cluster analysis to archaeological classification. They argue that the concept of a natural taxonomy and the idea of equal character weighting are inconsistent with the purposes of archaeological classification. Although proponents of numerical taxonomy will likely debate the validity of these criticisms for years to come, other more damaging criticisms of numerical taxonomy as a classificatory device have been presented by Dunnell (1971:109):

> As with other kinds of grouping, however, there is no way to discover, at least programmatically, what the groups mean in relation to a problem. The units so produced as groups are subject to all the criticisms voiced of statistical clustering. The meaning, the kinds of inferences which may be based upon such units, is problematic and intuitive (thus the labels "natural" or descriptive").

Dunnell (1971:107) feels that numerical taxonomy as a "grouping device" may be readily identified by:

> (1) the fact that the units always consist of aggregates of objects or events with locations in time and space; (2) the inability of the units to include additional members without redefinition; and (3) "definitions" which derive from the historical boundaries of the sample used in the original formulation and which take the form of enumeration or summary of the content of the units.

Such limitations of this technique, therefore, preclude its utilization as a means of creating groups; rather, it should be utilized as a means of treating the class members of pre-existing groups as Dunnell suggests. Numerical taxonomy provides a means of manipulating class members and formulating and testing inferences about their behavior. The occurrence of both distinctive and non-distinctive features of the class members of a classification may be summarized (Dunnell 1971:109).

Although Christenson and Read (1977) and Read (1974) share many of Dunnell's concerns regarding the use of numerical taxonomy, they argue that once variables have been classified and irrelevant variables removed, cluster analysis may prove to be useful for defining types. Christenson and Read propose that r-mode factor analysis is essential for the initial analysis of data. As Benfer (1967:729) points out, factor analysis may be used to determine relatively independent measures of the significant dimensions of artifacts. These dimensions, or factors, can be treated as simple variables and submitted to further analysis. The input of factor scores into a cluster analysis has been suggested previously by Sokal and Sneath (1963), Cattell (1965), and Tugby (1970). Ahler (1973) and Redman (1973) have previously applied such a methodology to archaeological data. More recently, Jefferies (1978:97-124) has applied Christenson and Read's methodology to a sample of Woodland projectile points from the southeastern United States.

Interestingly, the general research design suggested by Christenson and Read (1977) is structurally similar to a design for the analysis of archaeological characteristics originally proposed by Benfer (1967:719):

(1) Factor analysis to develop the descriptive characteristics of artifacts.
(2) Analysis of sources of variance to validate the archeological usefulness of the characteristics

found in (1).

(3) Grouping analysis and factor analysis to develop artifact types based on the characteristics found in (1) and validated in (2).

(4) Multivariate analysis to test the validity and usefulness of the types developed in step (3).

Benfer (1967) concentrated on the first two phases of the design, while Christenson and Read have focused on phases 1 and 3. Benfer sees a need to assess the spatial and temporal variability of individual attributes during an early phase of the analysis. Read (1974:241) would prefer to develop the typology first to allow the examination of such external references such as historical relevance. Benfer is apparently interested in variables which have significance only in a spatial or temporal dimension. Beyond these differences, however, both research designs attempt to avoid the tautological character of many analytical schemes where descriptive characteristics which reflect behavioral reality are both discovered and "validated" by considerations of temporal and spatial variability (Benfer 1967:729, Read 1974:241).

Thus, there are presently two alternative approaches to archaeological classification through statistical analyses. The first, discriminant analysis, is dependent upon the presence of a priori classes. The objective of this approach is merely to derive a mathematical basis for a traditional typology. Although the traditional typology is vindicated, no new information regarding the amount of variability present or the interaction of such variability is gained. The other approach, a combination of factor analysis (principal components) and cluster analysis (Benfer 1967, Christenson and Read 1977, Jefferies, 1978), makes no use of a priori classes; instead, factor analysis (in the generic sense) is used to reduce the dimensionality in correlated systems of measurements. Grouping is then achieved through the plotting of factor scores or submission of the factor scores to cluster analysis. This latter approach currently presents the greatest research potential. This potential, however, does not presently involve the creation of meaningful new types. This research continues to be exploratory in nature. Consequently, a summarization of the variability and occurrence of distinctive features of the members of a classification is the only legitimate product that can be expected at this time.

Analytical Procedure

Since the primary purpose of the projectile point analysis was to objectively evaluate the variability encompassed by the traditional formal typology, the general research design utilized by Christenson and Read (1977) and Benfer (1967) is followed. Deviations from their procedures are explained as they are presented. The sample for the statistical analysis is unfortunately much reduced from that available for traditional classification. Measurements of complete specimens

were judged to be necessary for factor analysis; therefore, only one hundred and forty-six (146) of 715 points were submitted for statistical analysis. Available factor analytical techniques allow for the inclusion of missing data; however, experimentation demonstrated that the overwhelming number of specimens represented by only the hafting element biased the factor analysis results. These 146 specimens were recovered from sites within both the North Fork and Granger Reservoirs. Their proveniences are listed in Appendix E. Diagnostic projectile points from the several phases are not equally represented; however, this is of little consequence, for this study focuses on the variability of the projectile points themselves--not their relationship to a given cultural phase.

The Attributes

The 31 attributes chosen for investigation included 14 quantitative measurements and 17 qualitative observations. The quantitative measurements are the traditional linear-angular measurements rather than the polar coordinate measurements utilized by Montet-White (1974) and Jefferies (1978). Although the reasoning behind the utilization of the polar coordinate technique is intellectually appealing, its superiority as a measurement technique remains questionable. Its inability to adequately record the variability of the hafting element of the projectile points (Jefferies 1978:101) is a matter of some concern and requires further evaluation.

Choice of the respective attributes for analysis was guided by the previous efforts of Benfer (1967), Luchterhand (1970) and Gunn and Prewitt (1975) and the desire to choose sufficient variables to adequately depict the overall morphology and dimensions of each specimen. Due to this all-inclusive approach to attribute selection, not all attributes were amenable to the eventual statistical analysis. Several of the variables fail to meet the data requirements of multivariate analysis. Nevertheless, all observations are presented in Appendix E.

Although the exploratory nature of this analysis required that sufficient quantitative measurements be taken so that no potentially significant dimension would be overlooked, simplicity and the replicability of such measurements were of primary concern. Consequently, measurements which were significantly influenced by observer bias were de-emphasized. Variables found to be of little value by Benfer's (1967:719-730) previous study were also ignored.

Measurement of the linear metric variables was accomplished with a sliding calipers and a measuring board. All metric measurements were rounded to the nearest millimeter. Angular measurements were accomplished by outlining the haft portion of the point on paper, bisecting the notches with the aid of a compass, and measuring the resulting angle with a protractor. A balance beam scale was utilized

to weigh the specimens to the nearest 0.1 gram.

Attribute List: Continuous Attributes (Fig. 14.2-1)

(1) Maximum Length (mm) - the maximum length of the point along its longitudinal axis. When the base of the point was concave, this measurement included the depth of the basal concavity.

(2) Maximum Width (mm) - the maximum width of the specimen (usually near the base of the blade) was used in concert with the maximum shoulder width to accurately record more ovate blade forms.

(3) Maximum Thickness (mm) - the maximum thickness of the point along its longitudinal axis.

(4) Weight (gm) - complete specimens only were weighed to the nearest .1 gram.

(5) Stem Length (mm) - the vertical distance from the base of the point to the blade/stem transition.

(6) Base Width (mm) - the width of the base of the stem.

(7) Neck Width (mm) - the width of the point at the blade/stem transition point. Contrary to the previous utilization of this term, this measurement is not necessarily the minimum width of the haft portion of the point (Luchterhand 1970:18) or the "highest, narrowest point on the haft" (Gunn and Prewitt 1975:142). Rather, this measurement merely records the width of the distal extremity of the point stem.

(8) Mid-Stem Width (mm) - width of the haft portion of the point at a point midway between its base and the blade-stem transition.

(9) Depth of basal concavity (mm) - the vertical distance from the lowest point on the base to the highest point of basal modification. Unlike previous efforts (Gunn and Prewitt 1975, Luchterhand 1970) convex bases were merely recorded qualitatively. The extreme arbitrariness of deciding the highest point of such basal modification renders any quantification highly suspect.

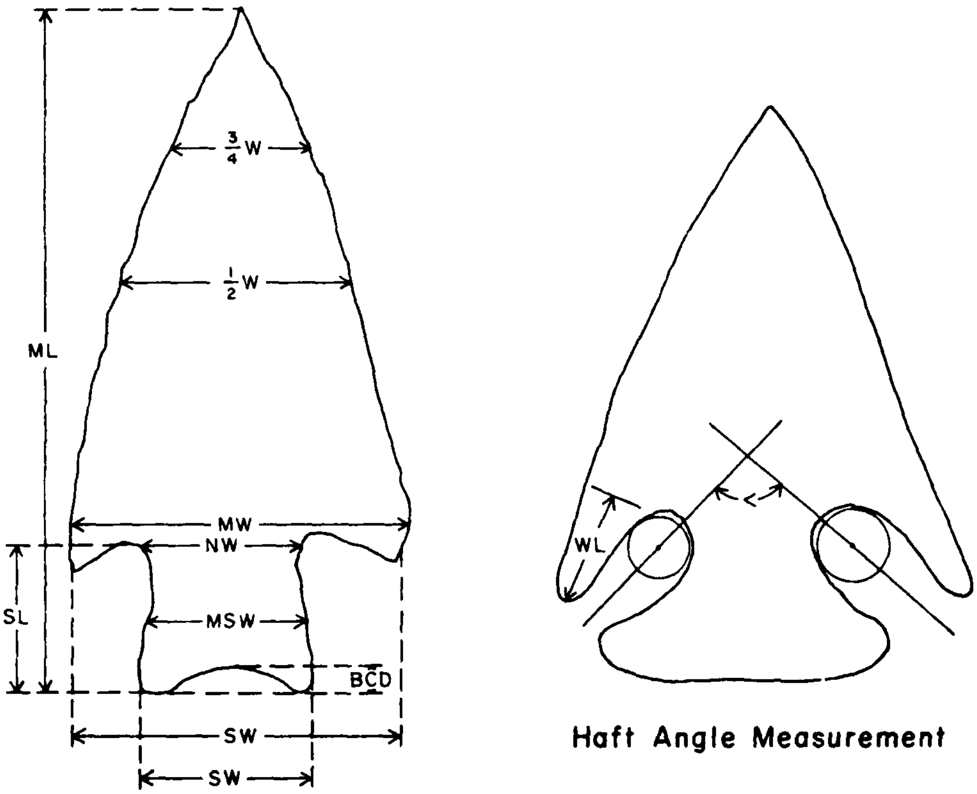
(10) Shoulder Width/Wing Tip Span (mm) - the width of the lowermost extension of the blade portion of the point. For most specimens this measurement is equivalent to the maximum width of the point.

(11) Wing Length (mm) - the maximum length of the wing along its longitudinal axis. Its distal extremity is that point where the blade joins the haft element.

(12) Haft Angle (degrees) - the measurement of the haft angle follows the definition of Gunn and Prewitt (1975:142):

> It can best be defined as the intersection of two lines which extend from the center of a circle drawn in the most angular area of the haft element, to the most angular point of the haft element. The angle is measured below the intersection.

Unlike Gunn and Prewitt, however, we have chosen to restrict measurement of this angle to only those specimens exhibiting a clearly delimited side, corner, or basal notch. This restriction avoids the arbitrariness of decision concerning the location of "the most angular area" and "the



ML Maximum Length
MW Maximum Width
SL Stem Length
BW Base Width
NW Neck Width
MSW Mid-Stem Width
BCD Basal Concavity Depth
SW Shoulder Width
WL Wing Length
½W Width of blade at ½ length
¾W Width of blade at ¾ length

Figure 14.2-1

most angular point" on such specimens as Bulverde, Pandale, Travis, and Gower points. The lack of clearly delimited notches on such specimens raises serious questions regarding the degree of precision that would be obtained through independent observers' measurements. Consequently, the importance of this variable in discriminating types is viewed with cautious skepticism. Since the majority of the specimens within our sample do not have clearly delimited notches, the haft angle is not an important part of our analysis. Other measurement techniques, such as Luchterhand's (1970:20-21) measurement of haft inclination, were also considered. Lack of precision in measurement, however, is still a problem given our sample of projectile points. As Benfer and Benfer (1981:390) have recently noted, such angle measurements may be utilized in multivariate analysis only if the values can be referred to a range of 180° or less and they have been transformed to a normal distribution.

(13) Width of Blade at 1/2 its Length (mm) - the width of the blade at the midpoint of the longitudinal distance between the stem-blade transition and the distal end of the specimen.

(14) Width of the Blade at 3/4 its Length (mm) - the width of the blade at a point which is three-fourths the longitudinal distance between the stem-blade transition and the distal end of the specimen.

Attribute List: Discrete Attributes

The selection of the following qualitatively defined attributes was partially influenced by the previous work of Benfer (1967:719-730) concerning a similar range of projectile point variability from Central and Southwest Texas. Various observations have been added to properly record the total range of variability within the San Gabriel sample.

(1) State of the point:

1. Whole--only these specimens were submitted for statistical analysis.
2. Damaged--specimens lacking their distal tip, a barb, or a portion of the stem. No attempt was made to project the outline of these specimens so that they could be included in the statistical analysis. The arbitrariness of such projections would completely nullify any purpose for their inclusion in such analyses.
3. Fragment--specimens with significant portions missing; quite often these specimens are unidentifiable as to type. However, to be included in this category these specimens must exhibit identifying characteristics of a stemmed projectile point; otherwise, they are recorded as biface fragments.
4. Reused as new of other tool type--specimens exhibiting differential flaking patterns or flake scar appearances (presence or absence of patina) which indicate that the original tool has been modified. Alteration may only slightly alter blade shape or convert the specimen to a drill or perforator.

(2) Burning (Presence/Absence) - presence indicated by heat spall

fractures and fine cracking of the specimen. Observation of this attribute provides information concerning the disposal pattern of points in active hearth areas.

(3) Blank type:

1. Flake--bulb or ventral face is present
2. Cobble--cortex present on one or both faces
3. No evidence of original surface
4. Reworked older point--same criteria as category #4 of "State of Point."

Although all four categories are represented within the San Gabriel sample, the overwhelming majority of the specimens exhibited no evidence of the original blank type. Beyond such documentation, this attribute was of no analytical value.

(4) Type of Secondary Retouch

1. Fine--the presence of light, uniform flaking along the edges of the piece. The resulting edges are sharp and straight in profile.
2. Normal--flaking is less uniform; greater in depth of flake scars produces a more sinuous edge.
3. Absent--edges are very sinuous; flake scars are irregular in size but consistently deep.

As with the attribute of "blank type", this attribute proved to be of little analytical value. The subjective nature of the categories precludes the use of such information within the statistical analysis.

(5) Reworking (Presence/Absence) - criteria the same as previous reworked categories. This category is somewhat redundant; however, it could have been more easily manipulated by the computer in this form, if it had been judged to be a significant aspect of projectile point variability.

(6) Distal Tip Shape:

0. Missing
1. Rounded
2. Pointed--triangular tip
3. Needle--triangular tip with needle-like projection
4. Propeller--alternate beveling of distal tip which creates a twisted or propeller-type appearance.

Several factors could affect the distal tip shape. If a given specimen was to be primarily utilized as a knife rather than a projectile, the knapper may have been inclined to produce a more rounded distal tip. If the specimen served as a dagger, a pointed tip would be desired for easier penetration. On the other hand, the rounded tips may be the result of tip breakage and subsequent retouch. Needle and propeller tips

likely served a more specialized function as perforators and drills, respectively. Unfortunately, the testing of such relationships lies beyond this study. Microscopic studies of wear patterns (Keely 1971, Tringham et al. 1974, Ahler 1971) are needed to test such hypothesized functional relationships. The morphological characteristics of each specimen are merely documented here.

(7) Medial Edge Shape (Blade edge only):

1. Straight
2. Convex
3. Concave
4. Recurved
5. Mixed--lateral edges of the blade are not of the same shpae.

(8) Beveling of the blade: steep retouch of the blade edges. Six categories are recognized for this attribute:

1. Beveling of one edge
2. Alternate beveling of two edges
3. Unifacial beveling of two edges
4. Bifacial beveling of two edges
5. All other possible combinations
6. Absent

(9) Serration (Presence/Absence):

0. Cannot be determined--most of blade is missing
1. Absent
2. Present

(10) Blade-stem transition (Fig. 14.2-2):

1. Weak shoulder
2. Strong shoulder
3. Barb
4. Wing
5. Mixed--any combination of the above

The weak-strong shoulder distinction is more arbitrary than one would desire. Perhaps, the measurement of shoulder angles would have provided greater precision for the separation of these two categories. Nevertheless, the lesser amount of time invested and the apparent consistency between the classifiers involved with this sample make this characterization of the blade-stem transition a practical one.

(11) Stem edge shape:

1. Straight
2. Convex

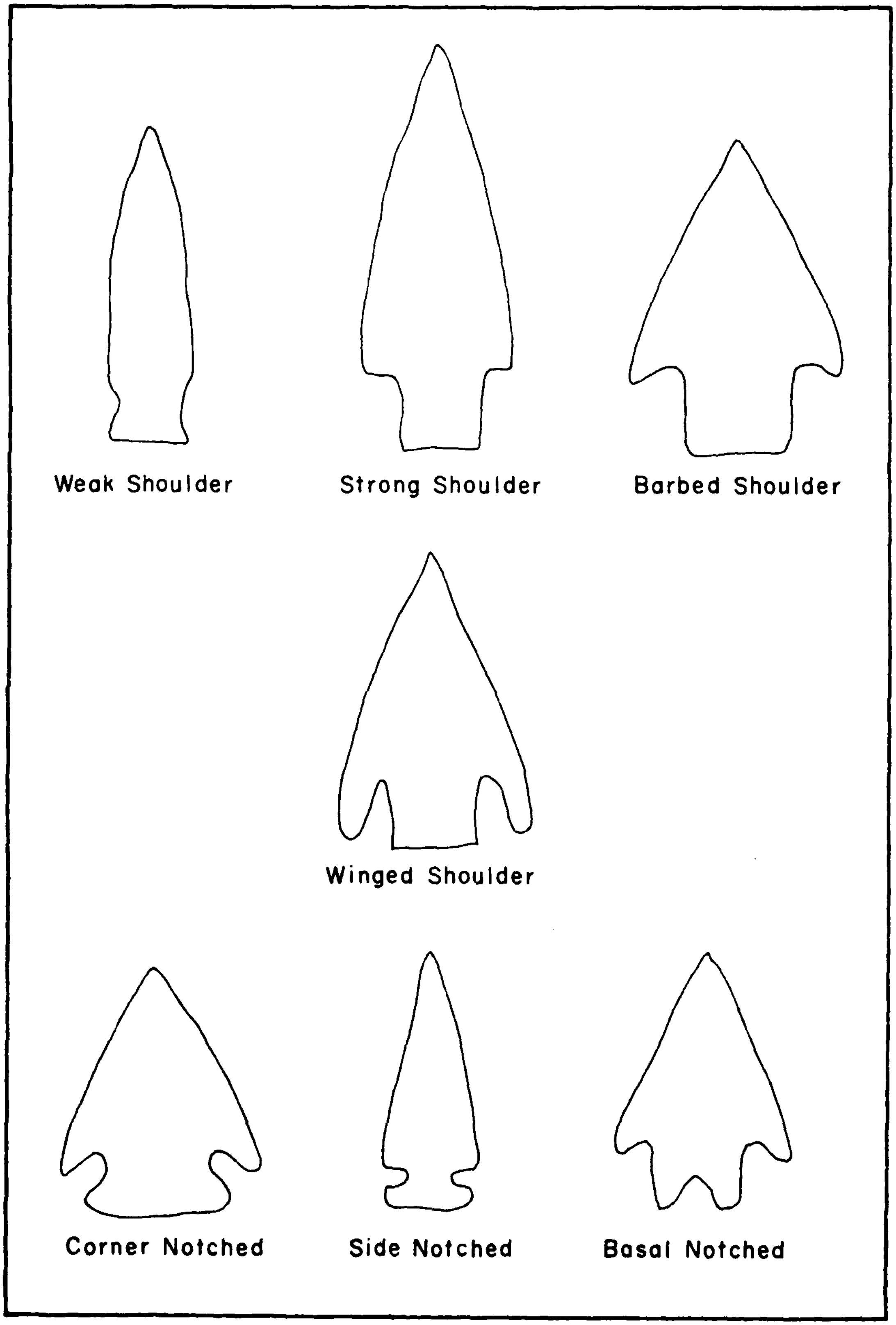

Weak Shoulder
Strong Shoulder
Barbed Shoulder
Winged Shoulder
Corner Notched
Side Notched
Basal Notched

Figure 14.2-2

3. Concave
4. Recurved

(12) Grinding of stem edges (Presence/Absence) - grinding of the lateral edges of the stem element to a smooth, polished surface. As Luchterhand (1970:21) points out, there may be difficulty in using consistent criteria for this attribute. Use of a hand lens and a second observer were the only methods utilized to achieve greater consistency within the San Gabriel sample.

(13) Beveling of the stem: steep retouch of the lateral stem edges. The same six categories that were used for the blade (10) are also used here.

(14) Notching (Fig. 14.2-2):

1. Corner
2. Side
3. Basal
4. Absent

As in the measurement of haft angles, the recognition of corner, side, and basal notching is limited to those specimens which exhibit clearly *delimited notches*. The use of such terms as "expanded corner notch" or "expanded side notch" is avoided.

(15) Stem base shape:

1. Straight
2. Convex
3. Concave
4. Recurved
5. Obtuse--angle produced by basal modification as exhibited by the Martindale point.
6. Acute - angle produced by a single basal notch.
7. U-shaped--form of basal notches exhibited by some Montell points.
8. Unshaped--proximal end of stem is unaltered, cortex is present.
9. Other

(16) Basal Thinning - the removal of narrow, shallow flakes from the faces of the haft element. These flakes are struck from the base of the stem and must extend well up the face of the stem. Shorter, secondary retouch flake scars along the basal edge do not qualify as basal thinning. Three categories are recognized for this attribute:

1. Unifacial
2. Bifacial
3. Absent

(17) Grinding of Stem Base (Presence/Absence): evaluation in the same manner as grinding of the stem edges.

Statistical Analysis

Before utilizing the basic research design of Benfer (1967), Christenson and Read (1977) and Jefferies(1978), a review of the data requirements for multivariate analysis, especially factor analysis, is necessary. Too often, archaeologists have selected multivariate techniques with little or no regard for the underlying basic assumptions regarding the input data. Perhaps the most basic assumption of the factor model is that the variables exhibit a bivariate normal distribution. Although normal univariate or marginal distributions are not sufficient for the bivariate distribution to be normal, the normality of all the data increases the likelihood. Consequently, transformation of the data to normality is a good course of action in all factor analysis. Transformations to normal distributions also decrease the chance that the range of the product moment correlation, if used, will be restricted (Rummell 1970:275-276).

Identification of normality or the lack of it can be accomplished by determing the kurtosis (peakedness) and skew (concentration of data on one or another side) of a distribution. If the data do not approach normality, transformations (log X_j, $(X_m)^{1/2}$ or $1/X_j$) can be applied to the data. Care should be taken, however, to check the distribution of the transformed data. Sometimes the transformations may be too powerful (Rummel 1970:283-284). Examination of the raw data from the projectile point sample revealed very few variables which did not exhibit a normal distribution. Depth of the basal concavity and the width of the blade at 1/2 and 3/4 of its length were the only original variables that required transformation.

The question of appropriate scale (nominal, ordinal, interval, and ratio) for the data submitted to factor analysis is one that is too often ignored. Rummel (1070:221-225) argues that all measurement scales may be utilized, but that nominal and ordinal scales must be employed with caution. The distribution of variables measured on a nominal or ordinal scale must be examined to determine whether the proportion of cases for any one scale value is not too large. If the frequency distributions are greatly skewed (95% of cases - 1, 4% of cases - 2, 1% - 3), the range of the correlation coefficient will be severely restricted. Traditionally, most computer programs utilize the product moment correlation matrix as input to the factor analysis. Unfortunately, most analysts have ignored the fact that the product moment correlation coefficient is not the proper coefficient to use when the data are of a nominal or ordinal scale and exhibit disproportionate splits. Other correlation coefficients such as phi, phi-over-phi-max, or tetrachoric are more suitable. Although analysts continue to debate the relative merits of these coefficients, the underlying assumptions of the tetrachoric coefficient

(cf. Rummel 1970:298-308) are compatible with our present data concerning the presence or absence of the discrete variables.

Since nominal measurement is restricted to two scale positions for factor analysis, all of the multi-state variables were converted and treated as dummy variables (0 = absence of straight base edge; 1 = presence of straight base edge) as Rummel (1970:224) suggests. Although Rummel (1970:224-225) leads one to believe that both nominal and ratio data can be submitted to factor analysis, several problems were encountered. First, both types of data were analyzed utilizing the product-moment correlation coefficient. Due to the scale differences of the two sets of data and the restriction of the correlation coefficient resulting from the disproportionate splits of the nominal variables, the nominal variables merely contributed to the formation of specific factors once the ratio data had formed the initial significant factors. Because of this problem the tetrachoric correlation coefficient was utilized even though only the nominal variables could be analyzed. A more basic problem was immediatley encountered. The use of the dummy variables dictates that the various states (straight, concave, convex) of a variable (stem base edge) are mutually exclusive. In other words, a straight base and a concave base cannot appear on the same specimen. Unfortunately, this creates calculation problems for the tetrachoric correlation coefficient matrix. The number of undetermined entries prevents any further analysis. Corrective calculations can be made for the empty cells. The resulting coefficient values, however, are hardly representative of the remaining cases (Guilford and Fruchter 1978:315-316). Due to these problems the nominal variables are merely recorded in Appendix E. Unfortunately, time and funding did not permit access to a multi-dimensional contingency table program, so that such data could be more rigorously examined. Consequently, the statistical analysis of the projectile point data focuses on the continuous metric variables only.

The continuous, metric variables present a different problem in relation to the use of the product moment correlation coefficient. Extreme cases, those that fall outside the normal range of variation of the data, have a biasing effect which tends to inflate correlations and create factors that may be statistical accidents. As Christenson and Read (1977:170) note, these extreme cases, or outliers, present a methodological problem in that they may reflect properties of the data not previously recognized or they may simply be idiosyncratic. Since we are dealing with a sample of several types of projectile points, the form of the variable distributions is the sum of individual unimodal distributions. Consequently, the outliers most likely represent idiosyncratic cases which should be removed from the statistical analysis. The outliers should not be removed from interpretive consideration, however, for they represent actual data which must be explained.

Following Christenson and Read's (1977:171-172) argument concerning the identification of outliers, the continuous metric data from the

146 projectile points were first submitted to principal components analysis before being input into an identification of outliers program. Principal components analysis is a model free descriptive procedure which involves a linear transformation of the original variables into a new, smaller set of orthogonal variables. In this manner the relevant variable clusters (factors) can be initially approximated and used as new variables in a program to remove outliers.

Table 14.2-1 presents the varimax rotated factor matrix of the original 146 projectile points and 10 variables. Only factors with eigenvalues greater than 1.0 were rotated through options available within the SPSS program (Nie et.al. 1975). Since all three factors are nonspecific (2 or more highly loading variables), each case can be measured on the three new variables provided by the factor scores. These factor scores were input into a BMDX74 (Dixon 1975) identification of outliers program. This program determines the outliers of a frequency distribution for any given alpha (α) value in a stepwise fashion. Since the true significance level of all tests for outliers combined is greater than alpha (Dixon 1953:77), a significance level of .05 was chosen for this data set. An alpha value greater than the traditional .05 significance level is probably most practical given the nature of archaeological data as a product of human behavior.

Twenty-six cases were identified as outliers (Table 14.2-2). Except for a very large Bulverde point, the most extreme cases were the Scallorn and Perdiz points of the Neo-American period. This was not unexpected, for the input of the raw, linear measurements would directly reflect the relative size of the dart points and arrow points, respectively. Consequently, all diagnostics of the Neo-American period were removed. Diagnostics of the Twin Sisters and San Marcos Phases comprise the largest portion of the remaining extreme cases. The variability among the cases of these periods is fairly great, for some were retained while others were not. The removal of the Fairland/Ensor points likely reflects the broad blades and somewhat unique stems which are characteristic of such specimens. Diagnostics of the Middle and Early Archaic are represented by two Pedernales and two Bulverde points. The overall greater breadth of these specimens contributed to their idiosyncratic position vis-a-vis the remaining points exhibiting a similar morphology.

Once the data had been screened for outliers, the remaining 120 cases (Appendix E) were submitted to factor analysis for interpretation. Once again principal components analysis and varimax rotation with Kaiser normalization were used (Table 14.2-3). Four components or factors accounted for 77.9 percent of the total variability measured by the selected variables. Factor 1, accounting for 40 percent of the total variability, represents the blade portion of the point as exhibiting the greatest variability. In other words, size of the blade ia an important dimension. Projectile points with broad, massive blades are represented within Factor 1. The variability of the stem portion of

Table 14.2-1

Varimax Rotated Factor Matrix (Kaiser Normalization) of Projectile Data Before Outlier Removal

VARIABLE	FACTOR 1	FACTOR 2	FACTOR 3	COMMUNALITY
Maximum Width	.70372	.55319	-.01473	.80146
Maximum Thickness	.44078	.17302	.70945	.72755
Weight	.84714	.11860	.44737	.93186
Stem Length	.10224	.07373	.92752	.87619
Base Width	.18506	.85834	-.17211	.80148
Neck Width	.38126	.77361	.33935	.85900
Mid-Stem Width	.26267	.90826	.09184	.90237
Depth of Basal Concavity	-.07307	.40343	.15898	.19337
Width of Blade at 1/2 Its Length	.88843	.34505	.07610	.91415
Width of Blade at 3/4 Its Length	.86739	.21083	.08628	.80426
Blade Length	.79138	-.10081	.23344	.69094
Cummulative Proportion of Total Variance	50.1%	66.6%	77.3%	

CASE NUMBER	CATALOG NUMBER	FORMAL TYPE	SITE	F STATISTIC	PROBABILITY	INPUT DATA (FACTOR SCORES)		
6	343	Bulverde	41WM 56	8.220	.0000	4.4329	- .9837	- .8303
110	4	Scallorn	41WM 258	6.430	.0004	-2.2381	-2.8137	-2.0611
108	1	Perdiz	41WM 258	6.696	.0003	- .7253	-3.4945	-1.8023
1	57	Scallorn	41WM 56	6.383	.0004	-2.1629	-1.9478	-2.2140
109	20	Scallorn	41WM 258	5.757	.0010	-1.1751	-2.1084	-2.1956
103	24	Scallorn	41WM 124	6.102	.0006	-2.0863	-1.6156	-1.7269
8	532	Scallorn	41WM 56	6.702	.0003	-1.6354	-1.8184	-1.8258
53	112	Frio	41WM 57	3.960	.0096	-1.8730	2.3134	-1.3293
85	10	Castroville	41WM 73	3.939	.0099	.2610	2.9091	- .8595
100	8	Unidentified	41WM 328	3.349	.0211	1.6205	- .9396	-1.9981
11	1301	Marshall	41WM 56	3.581	.0157	1.8099	- .0733	-2.2788
45	2321	Unidentified	41WM 56	3.413	.0195	1.9199	-1.6558	- .6825
19	172	Marshall	41WM 56	3.529	.0168	1.8690	.0524	- .9969
96	1680	Unidentified	41WM 56	3.277	.0232	1.3058	.2228	2.1499
10	1213	Pedernales	41WM 56	3.241	.0243	.4975	2.3219	-1.5247
143	702	Unidentified	41WM 267	3.129	.0281	1.6505	-1.5634	1.4737
23	1422	Fairland/Ensor	41WM 56	3.088	.0296	- .4515	1.8272	-1.8854
17	1538	Bulverde	41WM 56	3.148	.0275	.2514	- .5160	2.5783
105	3	Ensor	41WM 124	3.206	.0256	-1.3503	1.0697	-1.6434
3	41	Fairland/Ensor	41WM 53	3.214	.0253	- .9041	.9540	-1.8499
18	2321	Unidentified	41WM 56	3.178	.0265	1.5508	-1.6684	.9195
111	14	Darl	41WM 258	2.923	.0367	-1.0929	-1.2761	- .7487
62	56	Pedernales	41WM 57	2.778	.0442	- .7074	1.8905	1.0156
2	40	Fairland/Ensor	41WM 56	2.773	.0445	- .1275	1.7741	-1.4117
5	543	Fairland/Ensor	41WM 56	2.889	.0384	-1.5318	1.1831	- .8237
83	59	Castroville	41WM 73	2.843	.0408	1.3369	1.5063	-1.2387

Table 14.2-2. Specimens Identified as Outliers by BMDX74 Program

Table 14.2-3

Varimax Rotated Factor Matrix (Kaiser Normalization) of Projectile Data After Outlier Removal.

VARIABLE	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	COMMUNALITY
Maximum Width	.51994	.62553	.00415	.24719	.72275
Maximum Thickness	.42478	.02539	.61632	.07043	.56590
Weight	.84020	.27398	.41513	-.07247	.95859
Stem Length	-.08016	-.03279	.88728	-.03433	.79595
Base Width	.15547	.81588	-.32057	-.12189	.80746
Neck Width	.11793	.82593	.33595	.08170	.81561
Mid-Stem Width	.09724	.88835	-.00442	.15779	.82354
Depth of Basal Concavity	.07870	.11466	.01672	.88763	.80750
Width of Blade at 1/2 Its Length	.83601	.36151	-.00661	.24123	.88785
Width of Blade at 3/4 Its Length	.82069	.11492	-.03513	.27681	.76460
Blade Length	.70910	-.01308	.03572	-.34123	.62071
Cummulative Proportion of Total Variance	40.0%	56.8%	68.6%	77.9%	

the projectile point is represented by Factor 2. Factor 2, accounting for 16.8 percent of the variability, represents those projectile points with broad shoulders and stems. Within Factor 3 (11.7 percent of the variability) projectile point thickness and stem length are the major, contributing variables. Thick points with long, narrow stems are represented. Factor 4, accounting for 9.4 percent of the variability, is a specific factor in which depth of the basal concavity is largely independent of the other variables.

Except for Factor 4, the results of this factor analysis closely parallel those of Ruher and Frison's (1980:112-116) examination of the projectile points from the Vore Site in the Wyoming Black Hills. Montet-White's (1974) use of factor analysis in analyzing the interrelationships of projectile point dimensions also revealed similar patterning. Whether such patterning reflects universal relationships among the dimensional attributes of projectile point assemblages or is merely an artificial construct of the principal component analysis is not presently clear. Unfortunately, this problem has not been addressed by archaeologists who have readily incorporated factor analysis in their analytical methodology with little thought concerning its applicability.

Two methods are available for the definition of groups based upon the factor scores derived from the above analysis. The simplest procedure is to plot the factor scores univariately to determine if separate modes are present. As Christenson and Read (1977:172-173) have noted, the absence of modes does not mean that there are no clusters. Clusters may be present in the joint distribution even though each factor is uni-modally distributed. An examination of the plots (Figs. 14.2-3-6) of the factor scores of the four factors demonstrates that the univariate analysis is not sufficient for defining groups. Only Factor 4, largely reflecting the depth of the basal concavity, exhibits a bimodal distribution. Those projectile points exhibiting a deeper basal concavity tend to be found within the right cluster. Interestingly, not all of the Pedernales points are found within this cluster. Perhaps, the depth of the basal concavity of Pedernales points should be examined more closely in the future to determine if its distribution has any spatial or temporal significance.

Since the univariate plot of the factor scores was insufficient for grouping, a multivariate technique in the form of cluster analysis has been applied to the factor scores. The method of cluster analysis used to analyze these new variables of the projectile point sample (120 specimens) is average-linkage cluster analysis. This procedure avoids chaining by allowing a unit to join a cluster only if its average similarity with all existing members reaches a specified level (Doran and Hodson 1975). The particular program utilized for this analysis was the BMDP2M program (Dixon 1975:323-337) which provides for the clustering of cases (120 projectile point specimens in this analysis). Although the BMDP2M program offers a number of options, the sum of squares procedure which uses Euclidean distance as

-2.5	-2.25	-2.0	-1.75	-1.5	-1.25	-1.0	-.75	-.5	-.25	0	.25	.5	.75	1.0	1.25	1.5	1.75	2.0	2.25
								27											
								25				14							
								36				45							
								34				25							
								18				25							
								39				25							
								13				18							
								18		43		39							
								18	28	24		18							
				27				44	25	41		43		43					
				30				15	7	25	15	15		39					
				7	18		28	15	16	47	28	15		46					
				15	18	41	46	13	39	39	39	16		15		39			
		4		17	15	28	15	39	15	16	16	45		39		39	37		
		13		28	18	18	5	17	15	15	15	8	14	44	22	14	11		
15		18	13	28	16	15	21	26	18	17	34	13	18	17	16	24	10		
16		15	17	13	46	28	39	6	15	15	17	15	17	17	15	10	24		15

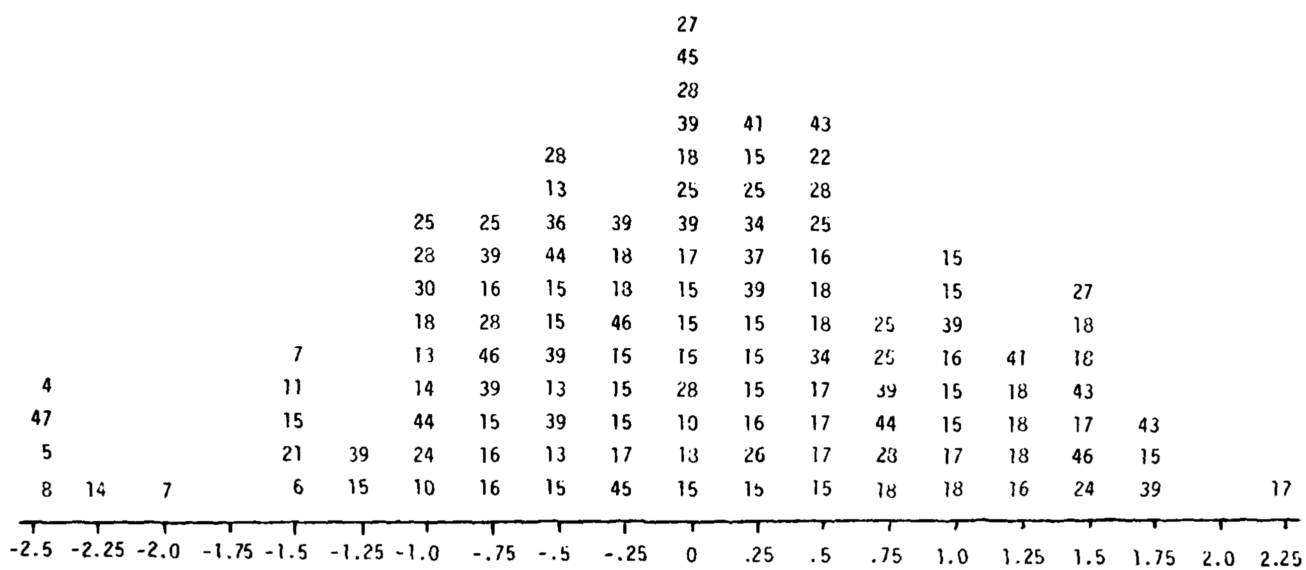
Distribution of cases on Factor 1 after outlier removal. The scale is in terms of Z-scores.

Figure 13.2-3

												14									
								25				43									
								28				15									
								18				13									
								25				39									
								7				7									
								18	15		27	44									
								17	25		22	28									
								16	15	39	45	46		4							
							43	39	18	37	28	16		18							
							41	47	43	16	17	15		16							
						41	25	15	15	18	46	15		15							
						25	18	15	39	18	15	44	27	11							
				28	30	39	39	16	17	15	17	15	16	15		13					
		36		28	28	45	18	5	18	15	46	18	15	21	39	15		13			
25		25	39	39	34	24	44	17	16	28	39	17	10	17	15	14		39			13
34		15	39	15	18	17	15	6	15	18	15	24	26	8	15	16	15	10			17
-2.5	-2.25	-2.0	-1.75	-1.5	-1.25	-1.0	-.75	-.5	-.25	0	.25	.5	.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	2.75

Distribution of cases on Factor 2 after outlier removal. The scale is in terms of Z-scores.

Figure 14.2-4.



Distribution of cases of Factor 3 after outlier removal. The scale is in terms of Z-scores.

Figure 14.2-5

-2.25	-2.0	-1.75	-1.5	-1.25	-1.0	-.75	-.5	-.25	0	.25	.5	.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	2.75	3.0
							14														
							27														
							27	34													
							30	18													
							41	37													
							28	18													
						22	28	39													
						25	36	39													
						25	25	4													
						25	16	18													
						28	18	18	43												
						25	18	17	41												
						39	28	18	25												
						13	16	16	30												
					43	18	13	39	39												
					28	39	28	39	39												
					18	44	39	14	13	25					15						
					11	18	45	39	16	39					15						
			13		17	24	34	28	44	7	47			46	15						
			17		10	16	17	17	16	44	15		15	46	15	7	15		15		
			10	43	8	17	16	17	15	15	15		21	15	15	15	15		15		
5			24	18	13	17	26	39	18	18	15	6	15	15	15	15	15	15	46		15

Distribution of cases of Factor 4 after outlier removal. The scale is in terms of Z-scores.

Figure 14.2-6 .

a measure of distance between cases is best suited for this data base. Amalgamation is by weighted averaging, and the weight is the number of cases in a cluster. The clustering begins by finding the closest pair of cases according to the distance matrix and comgining them to form a cluster. The algorithm continues to join clusters by measuring the distance to the center of clusters only. The clustering steps with the accompanying amalgamation distance for each step are shown in the output tree diagram.

The dendrogram (Fig 14.2-7) which resulted from the clustering of the 120 projectile points demonstrates that there is a significant amount of variability within this sample even though that variability has been reduced to four new dimensions--the four factor scores. Thirteen major clusters and numerous subclusters are present. Two projectile points, a Nolan and a Bulverde point, did not cluster with any other specimens until the final amalgamation step. From Figure 14.2-7 it is readily apparent that any one traditional formal type does not necessarily comprise a given cluster. This is hardly unexpected since the recognition of the traditional formal types relies upon a subjective assessment of the specimens overall shape together with the observation of the presence or absence of several discrete attributes not accounted for within this analysis. Nevertheless, two of the clusters contain Pedernales points only and several others contain specimens from a limited temporal span. There is obviously some correlation between the partitioning of the variability accomplished through the traditional formal types and the clustering of the variability exhibited by the ten original continuous attributes.

The spatial and temporal variability of each cluster is presented below. General observations concerning the morphological variability represented by each cluster are also presented.

Cluster 1: a fairly heterogeneous collection of 13 specimens from several temporal contexts. The superficial resemblance among the members of the group is related to the relative homogeneity of the blade and stem sizes.

Cluster 2: the majority of these 11 specimens were recovered from a Clear Fork or Round Rock component. Size is consistent throughout the cluster; relatively narrow blades and short, rectangular stems are characteristic.

Cluster 3: two-thirds of these fifteen specimens were recovered from a Clear Fork component. Overall morphological and size variability are very similar to that of Cluster 2.

Cluster 4: these four specimens are also from a Clear Fork context. Intra-group variability is fairly great, for two specimens exhibit more prominent shoulders.

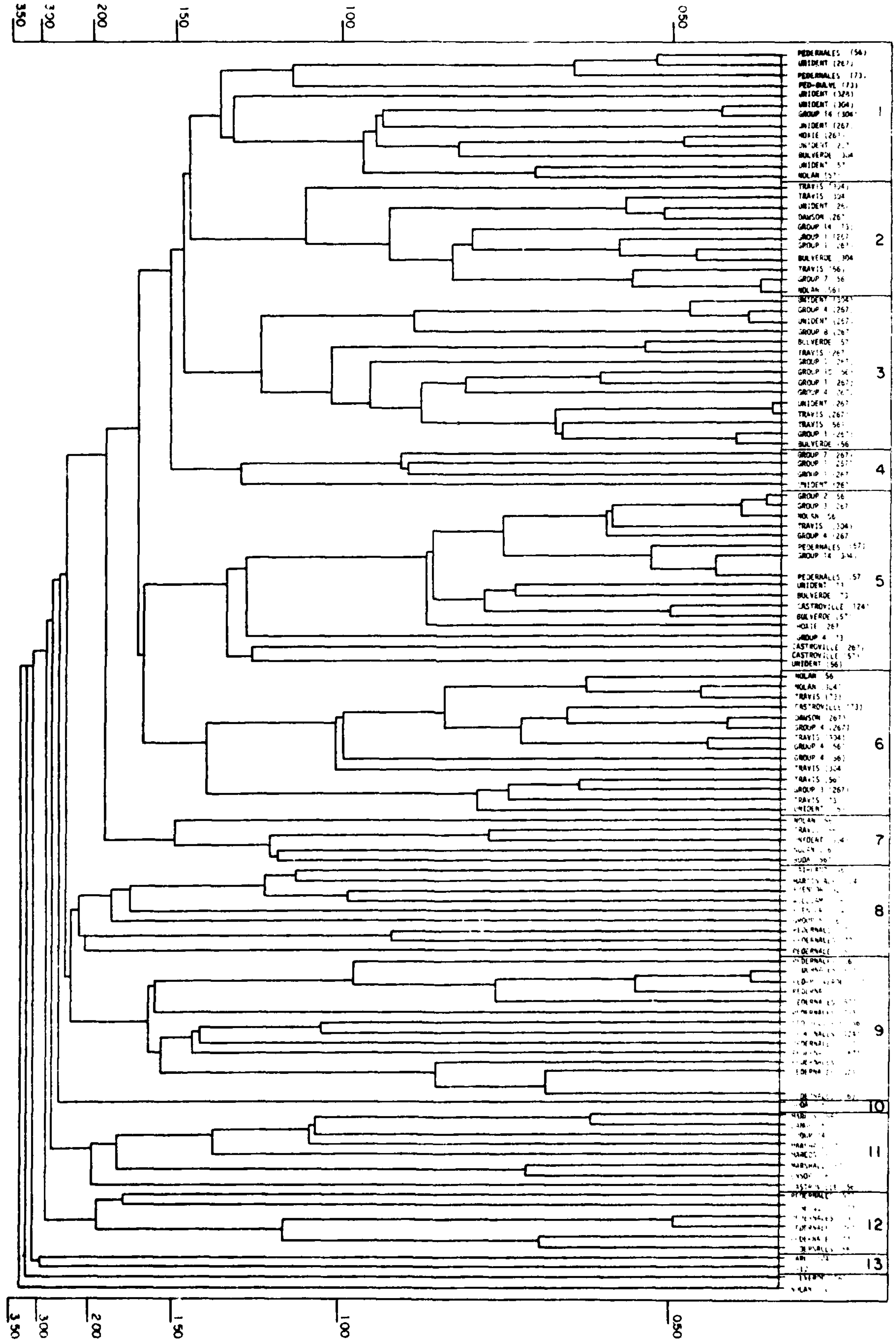


Figure 14.2-7 . Dendrogram of San Gabriel Projectile Points

Cluster 5: the temporal context of these seventeen specimens ranges from the San Marcos to the Clear Fork Phase. Blade length of the specimens varies significantly. The proximal portion of the blades and the stems of these specimens are broader than those in Cluster 3 and 4.

Cluster 6: These 14 specimens were recovered from either a Clear Fork or Round Rock component. Although blade length is variable, the overall morphology of the specimens is consistent. Blades are narrow; shoulders are not prominent; and stems are rectangular and narrow.

Cluster 7: These 5 specimens are from a Clear Fork or Round Rock component. The size of the blade appears to be the determining variable of this cluster. The sizes of the stems are homogeneous although stem shape is variable.

Cluster 8: Flaring stems, concave bases, and prominent shoulders or barbs are characteristic of this highly variable cluster (9 specimens). Three Pedernales points comprise a subset of this cluster. A Twin Sisters, San Marcos, Round Rock, and San Geronimo component is represented.

Cluster 9: This cluster consists entirely of Pedernales points from sites within both reservoirs. Size of these specimens is quite variable; the effect of Factor 4 (depth of basal concavity) is probably reflected by this cluster.

Cluster 10: One assymmetrical Buda point from a Clear Fork component comprises this cluster.

Cluster 11: Large, broad triangular blades and expanding stems are characteristic of this cluster. The eight specimens represent a variety of traditional types of the Late Archaic period. All of these specimens, except one, are from sites 41WM56 and 41WM57.

Cluster 12: Six Pedernales points which exhibit broad, assymmetrical blades and short, broad stems comprise this group. Specimens from both reservoirs are represented.

Cluster 13: Two specimens, a Darl and a Frio point, constitute the last group of points to be amalgamated.

The apparent heterogeneity of some of these clusters may be related to the observation of various researchers (Ahler 1971; Harold Hietala and Reid Ferring - personal communication) that R-mode factor analysis groups variables on the basis of extremes in various measurements, i.e., size. However, the extreme cases have already been removed from the data set. Consequently, the remaining variability as structured by the factor analysis should be representative of the specimens' overall variability. The actual patterning of the variability is not of so much concern as the possible significance of the patterning. In other

words, is blade size of any cultural and/or temporal significance within Central Texas? In aboriginal groups of the New Guenea highlands, size is an important variable of tool manufacture and use (White 1978). Perhaps it was also important to hunter-gatherers in Central Texas.

Christenson and Read (1977:170) note that the presence of several types within the data set may hinder the observation of the underlying structure of a set of variables. However, they also point out that the "dimensions along which the mean values of a variable for the several types tend to be most divergent, for instance, are also those dimensions that tend to best discriminate the types" (1977:170). The exception to this occurs when the variables contributing to the major dimensions of the factor analysis are not the variables reflecting the presence of the types. Admittedly, the size of the blade has never been a significant contributing factor within the traditional formal typology. This hardly detracts from its probable potential for inclusion in such efforts, however. Blade size may very well be related to function or target size which are sources of variation not addressed by the traditional formal typology.

In order to better evaluate the variability of these continuous metric variables in relation to their spatial (reservoir) and temporal contexts, each variable was submitted to two way analysis of variance (Nie et al.1975). Both the main effects (space and time) and the two way interaction effects were examined. All projectile points (554) of the Archaic period were submitted for analysis. Since many specimens were fragmentary, the number of actual cases utilized for the analysis of each dependent variable varied considerably. The SPSS ANOVA package (classic experimental approach) utilizes correction factors to accommodate such unbalanced cell frequencies. In order to better meet the underlying assumptions of the ANOVA test, such as the homogeneity of variance of the dependent variables, each observation was standardized prior to submission to analysis of variance.

The assignment of temporal period for the projectile points was based upon stratigraphic relationships within the two reservoirs and associated radiocarbon dates. These relationships fall within the previously recognized periods of the chronological framework for Central Texas (Prewitt 1974, Patterson 1977). The projectile points have been assigned to six temporal categories (Table 14.2-4). These assignments do not strictly follow the previously recognized chronological periods for Central Texas; however, the overall sequence is unchanged. As Benfer and Benfer (1981) have noted, there is an inherent danger of circularity in using the projectile point styles to establish such an analytical framework; nevertheless, the temporal framework for these styles is fairly well established.

Table 14.2-4. Assignment of Projectile Point Types to Temporal Categories for Analysis of Variance of Continuous Variables.

Temporal Period	Projectile Point Type
1 = Twin Sisters	Darl, Frio, Fairland, Fairland/Ensor, Ensor
2 = San Marcos (Late)	Montell, Marcos, Lange, Williams
3 = Early San Marcos	Castroville, Marshall
4 = Round Rock	Pedernales
5 = Clear Fork	Bulverde, Nolan, Travis, Dawson, Groups 1-8,14
6 = San Geronimo	Martindale, Hoxie, Andice, Wells, Uvalde, Groups 9, 10, 12, 13

The analysis of variance results were similar to those of Benfer (1967:721,725), for all of the variables reached significance in either time or space or both (Table 14.2-4). The spatial variable merely reflects the context of the specimen in either the North Fork or Granger Reservoirs. The Granger Reservoir specimens are primarily of an Early Archaic period; consequently, the spatial effect is greatly biased. Examination of the associated Multiple Classification Analysis (MCA) table (Table 14.2-5) for each ANOVA table in which the two-way interactions are insignificant (MCA ETA values are meaningless if there is strong interaction between factors) demonstrated that the spatial effect is likely an artificial construct of the data base. As in this example (Table 14.2-5) the ETA value (squared) for the spatial effect demonstrates that a very small proportion of the variability is accounted for by the spatial context of the specimens. Consequently, discussion of this analysis will focus upon the temporal effect.

Although all ten variables reached significance in this analysis, one cannot infer that these variables necessarily reflect the temporal ordering of the specimens in a direct manner. Examination of the MCA tables (Appendix F) associated with this analysis may be utilized to assess the patterning of this variability. The MCA tables exhibit the deviation of the specimens of each temporal category from the overall grand mean for each dependent variable. At a rudimentary level, then, the relationship of the variability of the dependent variable to the temporal sequence can be examined. The patterning of the attribute, maximum width, is hardly unexpected. The greatest positive deviation occurs on those specimens of Periods 2 and 3 (San Marcos Phase). The broad bladed specimens of these periods are easily recognized in relation to the earlier projectile points within Central Texas.

Table 14.2-5 Example of Two-Way ANOVA Analysis of Continuous Variables of Projectile Points from North Fork and Granger Assemblages.

BLADE WIDTH AT 1/2 ITS LENGTH BY TEMPORAL PERIOD BY RESERVOIR

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig. of F
Main Effects	65.904	6	10.984	17.932	.000
Temporal Period	59.468	5	11.984	19.417	.000
Reservoir	6.109	1	6.109	9.973	.002
2-Way Interactions	3.688	5	.738	1.204	.308
Explained	69.593	11	6.327	10.328	.000
Residual	132.923	217	.613		
Total	202.516	228	.888		

229 Cases Were Processed

MULTIPLE CLASSIFICATION ANALYSIS

Grand Mean = .08

Variable + Category	N	Unadjusted DEV ≠ N	ETA	Adjusted for Independents DEV ≠ N	BETA
Temporal Period					
1	36	- .92		- .95	
2	13	.78		.74	
3	27	.77		.73	
4	41	.26		.19	
5	94	- .13		- .11	
6	18	.24		.40	
			.54		.54
Reservoir					
1	167	.10		.11	
2	62	- .28		- .28	
			.18		.18

Interestingly, the width of the preceding Pedernales point style most closely approaches those of the San Marcos Phase. The negative deviation of the Period 1 specimens (Twin Sisters Phase diagnostics) resembles the variability of the Early Archaic specimens more closely. The width of the blade at 1/2 its length exhibits a similar pattern of variability. The Period 1 and 5 specimens exhibit relatively narrow blades while the remaining specimens are all above the mean value for this attribute. The width of the blade at 3/4 its length also exhibits this same pattern; however, the proportion of the variability explained by the temporal periods is only 16 percent. This is not unexpected since resharpening of specimens would have likely affected this attribute. The consistency of the patterning of the remaining blade width attributes and the relatively high proportion of explained variability (30-50%), however, suggests that blade width deserves more consideration in future studies of projectile point variability.

The attribute, maximum thickness, provides a clear separation between the specimens of Periods 1, 2, and 3 and all earlier specimens. Projectile points of the Twin Sisters and San Marcos Phases are distinctively thinner than the earlier specimens. Blade length, another attribute indicative of overall size, shows a pattern of variability similar to that of maximum width. Consequently, the broad specimens of Periods 2 and 3 are also the long specimens. However, the specimens of Period 6 (San Geronimo Phase) also exhibit greater lengths. Therefore, the proportion of variability explained by the temporal categories is only .12 for blade length. Forty-six percent of the variability of the attribute, maximum width, was explained.

Weight, perhaps the best indicator of overall relative size, provides yet another pattern of variability. The Period 1 specimens are the smallest as expected. Specimens of Periods 2, 3, 4, and 6 are also not unexpectedly the heaviest or largest. The diminutive size of the Period 5 specimens, especially Groups 4 to 7, is particularly interesting. Since the majority of these points were recovered from the Granger Reservoir sites, one might suspect that the size of the available raw material may have been a determing factor. However, the larger size of the debitage from these same sites (Chapter 14.4) leads one to question the above conclusion. Apparently the hunters of this period preferred a smaller dart point. Whether this preference was related to functional advantages or merely stylistic preference is presently unknown.

The attributes of the stem or hafting element of these projectile points exhibits three patterns of variability. The attributes, neck width and mid-stem width, display large positive values for Periods 2 and 3 and negative or very small positive values for the remaining periods. The attributes of stem length and base of stem width exhibit a break in the pattern of variability between temporal Periods 3 and 4. The Early-Middle Archaic to Late Archaic dichotomy is quite clear. The one remaining haft attribute, depth of the

basal concavity, shows a positive value only during the Round Rock, late San Marcos, and Twin Sisters Phases. Basal concavities were not common during the other phases.

Although the patterning is not entirely consistent, it is still clear that the variability of the Early to Middle Archaic specimens is fairly distinctive from that of the Late Archaic. This same general pattern is noticeable from the smaller sample submitted to factor and cluster analysis. From the analysis of variance tests, however, it is clear that certain variables are not as important as others from a temporal perspective. Blade length, width of the blade at 3/4 its length, and weight are all poorly correlated with time. The first two variables are easily understood, for reworking of a damaged or worn projectile point would easily change the blade length and distal blade breadth in relation to the other variables. Although one might expect either a fairly constant value or a steadily decreasing value for the weight of Archaic dart points, it is apparent that many of the Early Archaic points are diminutive. Whether this was due to functional requirements, size of available raw material, or personal choice is not clear at this time.

Conclusions

Experimentation with the multivariate research design advocated by Christenson and Read (1977) and Benfer (1967) raised several questions concerning the applicability of the analytical techniques to the entire data base and the interpretability of the results. Firstly, the inability of the factor analytical technique to easily incorporate the nominal data severely hinders an analysis of the full range of variability of each specimen. Analysis is limited to the relative size measurements of the various portions of the projectile point. Secondly, there is some concern that the size differences of the portions of the projectile point may be producing spurious results. The initial factoring of blade size attributes followed by stem size attributes may be an artificial product of the factor analysis technique. Thirdly, the cluster analytical technique merely provides groups of specimens exhibiting similar size variability. Whether these clusters reflect changes in artifact function, manufacturing techniques or patterns of symbol recognition is unknown.

Irrespective of the above noted problems, the patterning perceived through the multivariate analysis and the analysis of variance is similar to that recognized through the traditional formal typology. Admittedly, the pattern is more generalized due to the nature of numerical taxonomic methods to assess "overall similarity" (Sokal and Sneath 1963). As Schiffer (1967:94-95) notes, the only variables that can be measured with "shotgun" attribute selection procedures are probably relative time or gross size. In a general sense these two variables have been measured by the above procedures.

At a more specific level, the previous reliance upon the attributes of the stem as the decisive criteria for categorization is somewhat vindicated. Both the multivariate analysis and the analysis of variance procedure indicated that several of the stem measurements contributed to a significant dimension of the overall variability. Nevertheless, as Benfer (1967) has previously noted, the size and shape of the blade have been unduly neglected. On the basis of these preliminary studies, it may be postulated that blade size may be related to function or target size. Testing of such a postulation will require an examination of blade size in relation to edge damage, associated faunal assemblages, and site location.

While the above statistical procedures mirror the traditional scheme to a limited extent, they also objectively summarize the significant amount of variability present in the sample. A significant amount of this variability also crosscuts the traditional time periods recognized for Central Texas. Judging the significance of the patterning of variability remains a difficult task. Changes in behavioral subsystems, such as artifact function, manufacturing techniques, and patterns of symbol recognition (style change) are all probable dimensions of the overall variability. The generalized patterns perceived here may be a function of evolutionary distance or some other composite measure of behavioral change. As Schiffer (1967:95) points out, the limited success of multivariate techniques results from its close association with shotgun attribute selection procedures. More attention must be paid to the process of selecting relevant attributes (relevant to a particular dimension, not in a general sense as above).

Unfortunately, most of the intellectual effort to understanding projectile point variability has been directed toward the temporal and spatial dimensions. Consequently, the unwarranted assumption that a particular projectile point style equals a particular group of people plagues the literature. The relationship of particular variables to functional specialization has gone largely unexamined (Ahler 1970, Montet-White 1974). For example, do the blades and stems of the San Marcos Phase better fulfill a particular functional requirement than the prior projectile point styles? Is it also possible that the beveling of the stems of Nolan points allowed the binding of the hafting element to withstand the pressures created by utilization as a knife rather than as a projectile? Such questions remain unexamined, for we are all too busy establishing chronologies and culture areas. Admittedly, such endeavors are necessary for we must be able to relate cultural processes to time and space. However, theoretical models concerning the technological, functional, and stylistic variabi-ity of projectile points also need to be constructed and tested. Montet-White's (1974:14-24) systems model relating point manufacture and use to hunting strategies is a step in the right direction. Explanation of projectile point variability is to be found in a complex of factors. As Montet-White (1974:16) notes, the points will not necessarily indicate the time period that a site was occupied, but they may provide significant information on the technoeconomic organization of the people who used them.

The multi-dimensionality of this problem area will require the continued utilization of objective multivariate analytical techniques. Which techniques will be best suited and most relevant to the particular problems engaged remains to be determined. The approach utilized here was useful in that it summarized the variability present within the sample and indicated that certain attributes need to be more closely examined in future research. However, the inherent problems associated with this analytical procedure suggests that alternative multivariate procedures should be examined. The inability to deal with nominal attributes is a very serious limitation in itself. Furthermore, there is the very real possibility that the factor analysis patterns may be an artificial construct of the principal component analysis. This problem must be explicitly addressed by archaeologists in concert with statisticians, if this methodology continues to be utilized. This initial assessment of "overall similarity," although important, is also insufficient for the model testing discussed above. In order to isolate the variability of specific dimensions of the projectile points, the above procedures will likely be more useful in examining the variability within a particular point type. Other analytical techniques, such as multi-dimensional contingency tables (TRICHI, ECTA) will be useful for relating this variability (categorical and metric) to site type, site location, site size, and the associated tool assemblage. Experimentation in the manufacture of lithic tools will also help in the definition of the technological constraints on such variability. The use of a systemic approach to this problem area and the selection of appropriate attributes and analytical techniques will hopefully provide an avenue to explanation, rather than more "pigeon-holing," of projectile point variability.

14.3 Lithic Tool Typological Analysis

by

Marie-Anne Demuynck

North Fork Reservoir

Site 41WM53

I. Scrapers

All 8 scrapers from this site were recovered from areas A and B only; there were no scrapers found in area C.

A. single endscrapers

1. single endscrapers on retouched flakes: n = 2 (1 whole)
One complete and one fragmentary endscrapers on retouched flake were made on a Sb and a tertiary flake, respectively. Both specimens are small tools, where the small scraper bit is regularly retouched by small to medium steep to oblique dorsal retouch. The complete scraper has some additional oblique dorsal retouch on the right edge. The other tool has fine steep retouch on the left edge, ventral on distal part, dorsal on proximal.

2. inverse scrapers: n = 1 (whole)
This inverse scraper is a unique specimen. It was made on a rather irregularly shaped tertiary flake; the distal end, of which being already partially shaped by a hinge fracture, was retouched by steep medium to small ventral retouch.

B. single sidescrapers

1. single sidescrapers n = 1
The single sidescraper fragment from this site, made on a Sb blade, has its scraperbit along most of the left edge made by oblique to steep medium-sized dorsal retouch. The scraperbit has a slightly concave outline. The blade is naturally pointed at the distal end, snapped at the other end, and was recently damaged on the right edge.

2. single sidescrapers on retouched flake: n = 1 (whole)
A single sidescraper was manufactured on a retouched Sb flake. The scraperbit is located on the entire left edge, made by steep large and very large but regular dorsal retouch, with a small thorn on the distal corner. The right edge is also retouched by large dorsal retouch but irregular and denticulated. The proximal end was truncated initially by large steep dorsal retouch, subsequently also retouched on the ventral face by very large flat retouch. There is also regular fine dorsal retouch on the distal end, much smaller than on the rest of the tool.

3. single sidescraper on a backed blade: n = 1
A single sidescraper is made on a tertiary backed blade. The scraperbit is made on the right edge by steep medium and large dorsal retouch, with few ventral retouch. The other edge is backed, partially naturally, partially by steep medium dorsal retouch and few flat large ventral retouch. Bulb and platform were removed by irregular bifacial oblique retouch. The tool is fractured on the distal end.

C. Double Scrapers

1. single end and singlescraper : n = 1
The only double scraper recovered from this site was made on a large and heavy Sa flake. One scraper bit is on the right edge, made by large steep to oblique dorsal retouch. The scraper on the distal end is irregular, slightly denticulated, and manufactured by bifacial retouch. The left edge is cortex backed, and the proximal end is multi-fractured.

D. Fragments: n = 1
One fragment was recovered from this site, possibly a scraperbit renewal flake. The proximal end of the flake is missing. If the fragment is a renewal flake, it would be one of type 3 (for explanation, see 41WM56).

II. Denticulates

A. Serrated tools: n = 1 (burned)
This tool is a fragment of a triangular shaped artifact made on a Sa flake; its base is retouched slightly concave by bifacial retouch and both edges are irregularly denticulated. This tool fragment is probably a small triangular point fragment, of which the pointed end is missing.

III. Notched Pieces

A. single notches on flakes

1. single notch only: n = 15 (10 whole, 3 burned)
The tools were made on tertiary flakes, 4 on secondary b flakes and 1 on a secondary a flake, 9 by dorsal retouch, and 6 by ventral retouch. All dorsally retouched notched are located on flake edges; while for the ventrally retouched notches, 1 is on the distal and 1 on the proximal extremity.

B. multiple notches on flakes

1. occassionally 2 adjacent notches: n = 3 (1 whole)
One tertiary and 2 secondary b flakes have at some point two adjacent notches, all retouched dorsally, and at least one more notch somewhere on the flake.

One tool is partially bifacially retouched on 1 notch, and may be a damaged graver, but since the graver point would be missing, it cannot be identified precisely.

2. adjacent notches, alternating retouch: n = 1 (whole)
A tertiary flake has 2 adjacent notches, retouched alternatingly on the left edge, and continuous steep dorsal retouch on the right edge.

C. Notched blades, bladelets, and microblades

1. single notch: n = 1 (whole)
A secondary b blade has a single dorsally retouched notch on the distal part of its left edge, and is further unmodified.

D. Other

1. meganotch: n = 1 (whole)
A tertiary flake has a large, carefully dorsally retouched notch in the middle of the left edge. The tool is otherwise unmodified.

2. alternatingly retouched nonadjacent notches: n = 1
A tertiary flake fragment has 2 rather large notches in equivalent loci on both edges, one dorsally retouched, the other one ventrally. One notch is incomplete, due to a fracture.

E. Fragments: n = 3 (burned)
All 3 fragments are tertiary with parts of dorsally retouched notches; one fragment had at least 2 notches.

IV. Boring Tools

A. Gravers

1. gravers on flake axis: n = 1 (burned)
This tool is a small, sharply pointed graver on the distal end of the length axis of a tertiary flake, made by oblique dorsal retouch.

2. gravers on the flake edge: n = 1
This tool is a fragment of a not very pronounced 'beaked' graver, made on a tertiary flake.

B. Borers

1. oblique borers: n = 3 (1 whole)
There are 3 oblique borers, 2 were made on a tertiary flake, and 1 on a secondary b flake. All three have square, but very sharp borer points.

2. <u>other borers</u>: n = 1 (whole)
   This fourth borer recovered from this site is a unique specimen. It was made on a tertiary plunging flake, removing part of what was propably a scraper bit. Then one end with a triangular cross-section was retouched into a sharp point by retouch from the distal end towards the former scraperbit.

C. Perforators: n = 1
   This tool was made on the axis of the distal end of a secondary b flake by bifacial non-covering retouch on both edges.

D. Drills

1. <u>drills on bifacially retouched base</u>: n = 1 (whole)
   One complete drill was recovered from this site; the tool has a basically quadrangular base, tapering slightly towards the beginning of the drillbit. The bifacial retouch is completely covering on both faces.

2. <u>drill fragments</u>: n = 1 (burned)
   This fragment is a small part of a drill bit.

V. Truncations

A. Distal truncation

1. <u>dorsal retouch</u>: n = 5 (2 whole, 1 burned)
   All tools were made on tertiary flakes; the truncations are straight, and one also oblique.

   A large tertiary flake, truncated by steep medium dorsal retouch, was retouched alternately over most of both edges, dorsal on the right edge, ventral on the left edge.

2. <u>ventral retouch</u>: n = 3 (whole)
   All three tools were made on tertiary elements; one on a large blade. They were all straight truncations.

B. Proximal Truncation

1. <u>ventral retouch</u>: n = 2 (1 whole)
   Both truncations were made on tertiary flakes, one of which has additional small dorsal retouch.

C. Double truncations: n = 1 (whole)
   A narrow secondary b flake or possibly a bladelet was truncated at both ends by steep dorsal small retouch; the proximal one is slightly concave, the distal one oblique straight.

VI. Backed pieces

A. One whole edge backed

1. <u>straight or slightly convex edge</u>
   a. dorsal retouch: n = 1 (whole)
   The whole right edge of this small teriary microblade was steeply and very regularly backed by medium-sized dorsal retouch.

   b. ventral retouch: n = 2 (1 whole)
   One tertiary flake and 1 tertiary bladelet fragment were ventrally backed on the right and left edge, respectively.

2. <u>convex edge</u>
   a. dorsal retouch: n = 1
   A strongly curved part of a backed edge is preserved on a tertiary flake fragment.

3. <u>concave edge</u>
   a. dorsal retouch: n = 2 (1 whole)
   One tertiary blade and a fragment of a tertiary flake were steeply backed on the right and left edge, respectively. In both cases,the concavity of the backed edge is very slight but distinct.

B. Special

1. <u>backed and truncated tools</u>: n = 1 (whole)
   A patinated tertiary distal flake fragment was backed steeply by ventral retouch on its left edge, and truncated equally steeply by ventral retouch on its proximal end. The right edge has some discontinuous retouch.

C. Fragments: n = 1
   This tool fragment is a medial part of a left dorsally backed flake edge, without cortex.

VII. Burins

A. Angle burins

1. <u>single angle burins</u>
   a. on snap: n = 1 (whole)
   The only single angle burin on snap was made on a large pointed biface fragment, which was flaked by large but careful retouch. The burin was made by a single blow.

   b. on platform: n = 2 (whole)
   Two other single angle burins were made on flakes, from a facetted striking platform, not furthrr prepared by any retouch or fractures; this preparation, anterior

to the flake itself, is single facetted for both tools. One burin is multifacetted, and has rough and irregular additional retouch on some edges.

2. double angle burins: n = 1 (whole)
There is only one double burin on angle, made on one extremity of a basal biface fragment, that contained a lot of cortex on one face. One burin bit was made multifacetted, the other one single facetted.

B. Dihedral burins

1. on angle: n = 2 (wnole)
Two dihedral burins on angle, both made on tertiary flakes, were recovered at this site. For each tool, one burin facet was renewed at least once, and each tool was further retouched along its edges on the remaining edges and the proximal end by rather irregular oblique small to medium retouch, partially bifacial.

C. Transversal burins: n = 2 (1 whole)
Two transversal burins were both made on tertiary flakes, one of which is a very heavy one; the latter also has large and broad multiple burin scars on the distal end, which give the burin bit a somewhat denticulated outline. The proximal end of this tool is missing. The other burin is also multifacetted, but incomplete.

D. Unidentifiable fragments: n = 1
There is one burin fragment that could not be clearly classified; it was manufactured on a secondary flake with less than 50% cortex that has been retouched ventrally on the proximal end, dorsal and partially bifacial on the distal end. The burin blow is given from an unprepared platform on the right edge.

VIII. Composite Tools: n = 1
This tool, a scraper-graver combination, was made on a tertiary flake, retouched very regularly on both edges. On the right edge is a single side-scraper, on the left a 'beaked' graver was made on a steeply beveled edge. All retouch is on the dorsal face.

IX. Retouched pieces

A. Pieces with unilateral retouch

1) dorsal retouch
a. retouched edge
1. nearly entire edge: n = 26 (8 whole, 3 burned)

The complete tools are

made on		ret. left edge	right edge
tert. flakes	4	2	2
Sb flakes	4	-	4
		2	6

Remarkable about this assemblage is the overall very small size of the flakes, the tertiary flakes generally smaller than the secondary flakes. The retouch is small and steep to oblique.

The fragments are

made on		ret. left edge	right edge
tert flakes	13	7	6
Sb flakes	4	2	2
Sa flakes	1	-	1
		9	9

With few exceptions, most fragments are small and very similar to the whole pieces discussed above.

2) less than half edge: n = 13 (11 whole)

The complete tools are:

made on		ret. left edge	right edge
tert. flakes	6	3	3
Sb flakes	3	3	-
Sb blades	1	1	-
Sa flakes	1	-	1
		7	4

Most tools have been partially retouched on the proximal part of their edge, only 2 on the distal part. The heavy Sa flake is retouched in the medial part.

The 2 fragments recovered are a tertiary and a Sb flake, both retouched medial to distal on their left edge.

b. retouched end

1) distal end: n = 6 (5 whole, 2 burned)

made on		whole	fragments
tert. flakes	3	2	1
Sb flakes	3	3	-
		5	1

All tools are flaked by oblique to steep small marginal retouch over most, but not the whole distal end.

2. ventral retouch
   a. retouched edge
      1) nearly entire edge: n = 6 (3 whole)
         All 3 complete tools are thin tertiary flakes, with fine continuous oblique retouch along the right edge.

         The fragments are

made on		ret. left edge	right edge
tert. flakes	1	-	1
Sb flakes	2	1	1
		1	2

         The 2 Sb flakes are very small fragments.

      2) less than half edges: n = 8 (3 whole, 2 burned)
         Two complete tertiary flakes were retouched on their right edges, 1 distal and 1 proximal. A tertiary bladelet was retouched proximal on the left edge.

         Three tertiary flake fragments were retouched right, 2 left; in 2 cases the retouch was proximal, the others were medial.

   b. retouched end
      1) distal end: n = 2 (whole)
         Two tertiary flakes were retouched obliquely by small and medium retouch on part of their distal end.

3. bifacial retouch
   a. retouched edge
      1) nearly entire edge: n = 3 (1 whole)
         The left edge of a Sa flake was irregularly bifacially retouched by few, large flakes. A Sa and a tertiary flake fragment were retouched bifacially by small, but irregular retouch on their right and left edges, respectively.

      2) less than half edge: n = 1 (whole)
         A small medium part of the left edge of this tertiary flake was finely bifacially retouched.

   b. retouched end
      1) distal end: n = 1
         Part of the distal end of this tertiary flake was irregularly bifacially retouched.

4. alternating retouch
   a. retouched edge: n = 2
      Two tertiary flake fragments were retouched alternately by small flat/oblique retouch, one on the left edge, the other on the right edge.

5. discontinuing retouch
   a. retouched edge: n = 1 (burned)
      A large and heavy Sa flake fragment was retouched on the left edge.

   b. retouched end: n = 1 (whole)
      A Sb flake was retouched discontinuously by small retouch on its distal end.

B. Pieces with bilateral retouch

1. dorsal retouch
   a. 2 retouched edges
      1) 2 partial edges, equivalent loci: n = 1 (burned)
         A Sb flake was partially retouched near the fracture on the distal extremity.

   b. 2 partial edges, unequivalent loci: n = 1 (whole)
      A Sb flake was flaked by small oblique to steep retouch, more proximal on one edge, more distal on the other one.

   c. 1 edge and 1 end
      1) both partially: n = 1 (whole)
         A tertiary flake was flaked by steep, small retouch on parts of the distal end and right edge.

      2) both nearly entirely reotuched: n = 4 (3 whole, 2 burned)
         All 4 tools are tertiary flakes, retouched by small oblique to steep retouch.

2. ventral retouch
   a. 2 retouched edges
      1) 2 rearly entire edges: n = 2 (1 whole)
         Two Sb flakes were retouched by oblique small retouch over both edges.

3. bifacial retouch
   a. 2 retouched edges: n = 2
      Two tertiary flake fragments were bifacially marginally retouched, one of the fragments by small very regular retouch.

4. alternating retouch
   a. two edges, 1 retouched alternating: n = 2 (1 whole)
      Both tools were made on tertiary elements, by small oblique retouch.

5. alternate retouch
   a. 2 edges

      1) 2 nearly entirely retouched edges: n = 4 (1 whole)
         These tools were

made on		whole	fragment
Sb flakes	3	1	2
Sa flakes	1	-	1
		1	3

         The one complete Sb flake is very small; another tool was made on a Sb core trimming flake.

      2) Both edges partially retouched, equivalent loci: n = 1
         This tertiary fragment was made by small oblique to flat retouch, not very regular.

   b. 1 edge and 1 end: n = 3 (1 whole, 2 burned)
      Two tools were made on tertiary flakes, 1 on a Sb flake. For all specimen, the retouch is rather irregular, usually oblique small, sometimes a little larger.

C. Multilateral pieces

   1. dorsal retouch: n = 1 (1 whole)
      All edges except the proximal end of this tertiary flake were flaked by fine and small retouch.

   2. mixed bifacial and unifacial retouch
      a. 2 edges and 1 end
         1) 1 edge retouched bifacially: n = 2 (whole)
            Two tertiary flakes were roughtly, partially bifacially retouched by oblique or flat medium retouch.

   3. mixed unifacial retouch
      a. 2 edges and 1 end: n = 1 (whole, burned)
         This tool was made on a burned tertiary flake by fine, small irregular retouch.

   4. discontinuous retouch: n = 1 (whole)
      A large tertiary flake, possible a core trimming flake, was retouched on 3 other edges.

D. Special retouched pieces

   1. pointed flakes and blades: n = 1 (whole)
      A small tertiary flake was retouched to an oblique obtuse point by few mainly dorsal retouch.

2. retouched burin spalls: n = 2 (whc e)
   One burin spall was retouched ventrally on the blunt distal end, the other one had few dorsal retouch on both edges, on 1 edge near the proximal end, on the other edge near the distal end.

3. tool fragments on "eclats outrepassés"(or "plunging flakes"): n = 1
   This complete Sb flake contains part of a tool, possible a scraper or backed piece fragment.

4. other: n = 1 (whole, burned)
   A totally natural flake with triangular cross-section was retouched by small oblique dorsal retouch along 1 edge.

E. Unidentifiable fragments: n = 46 (7 burned)
   These fragments were made on: Sa flakes (3), Sb flakes (11), tertiary flakes (29), natural flakes (1), chips (2).

X. Bifaces

A. Small bifaces, triangular and subtriangular

1. with a concave base, thick in cross-section: n = 1 (burned)
   A very small irregular triangular biface, was recovered from a feature associated with the Austin/Twin Sister transition. The biface is badly burned, rather thick and has a slightly concave base. A similar tool was recovered at site 41WM56.

2. with a convex base, thick in cross-section: n = 1
   A small, somewhat irregularly bifacially retouched triangular biface, was found in an Austin-Twin Sisters transition context. The base is only slightly convex, with rounded corners.

3. with a convex base, thin in cross-section: n = 1
   A small thin bifacially retouched subtriangular biface, recovered from Austin dated levels, was made on an older patinated flake; a small part of a ventral face is preserved on 1 face. The tool is assymmetric, with 1 strongly convex edge. The tool has rusted iron marks on a surface, and the base is damaged. The iron marks are probably plowscars, and the tool was therefore not in situ.

B. Medium and large bifaces

1. irregular subtriangular: n = 1
   Large irregularly retouched subtriangular biface was slightly damaged on tip and 1 edge. The base is thinned, bifacially and one edge is considerably better retouched than the other. The biface edges are more or less parallel for most of the tool length, before tapering to a point. This tool was recovered from Twin Sisters levels.

2. elongated triangular bifaces, medium length: n = 1
A medium large biface, very similar to 2 other tools found at the sites 41WM56 and 41WM57, was in this site discovered in Twin Sister context. A very small part of a patinated former biface edge is preserved on 1 edge. Maybe this tool is a totally reworked older tool.

C. Miscellaneous

1. elongated quadrangular biface: n = 1
A small bifacially retouched tool was found in Austin context at the site. Although the tool is bifacially retouched all around the edges, a relatively large amount of cortex still remains on the upper face. The flat underface has been retouched completely.

D. Preforms

1. intensively worked preforms
   a. medium sized suboval or subcircular tools: n = 1
   The only probably unfinished tool recovered from this site is a bifacially worked, relatively thin artifact, irregular suboval in outline. It was recovered in Austin/Twin Sister transition context.

   Similar tools were also found at sites 41WM56 and 41WM267 (for dates, see respective sites).

E. Biface fragments

1. basal fragments
   a. basal fragments with a more or less straight base, the edges at right angles to the base: n = 4
   Four such fragments were recovered from this site. The smallest one, made on a flake, is probably a pointstem, as is also possible for another fragment, although that would be for a very large projectile point. One other fragment still has some cortex on one face.

   b. basal fragments with a more or less straight base, edges at sharp angles to the base: n = 4 (burned)
   Three small and one medium-sized fragments were recovered from this site. One small burned fragment is probably a pointstem fragment, the 2 other small fragments are probably unstemmed point fragments. All fragments are bifacially secondary retouched.

   c. basal fragments with a more or less straight base, edges at obtuse angles with the base: n = 8 (burned)
   Two large, two medium and four small fragments were found. The two smallest fragments, one of which is burned, are possibly point fragments. All four larger pieces still have small amounts of cortex. Two of these have a

secondary unifacially retouched base, one made on a fracture plane; the other one after normal primary retouch.

d. basal fragments with convex base: n = 7 (1 ? burned)
The two fragments made on flakes, both have cortex on the dorsal face and are bifacially retouched on edges and base, as all other fragments. Both were made on older patinated flakes. One of the larger fragments also has cortex on 1 face.

e. basal fragments with a concave base: n = 5
There are 3 large and 2 small fragments, the latter two probably projectile pointstem fragments. The 3 larger fragments are very similar with carefully retouched edges and also carefully bifacially thinned bases.

f. pointed base fragments: n = 1
One such fragments was recovered from this site, possibly made on an older patinated flake.

g. shouldered and stemmed basal fragments: n = 2
One fragment is possibly a large and wide projectile point wing. The other fragment is damaged on 1 basal corner; the other edge has a square shoulder and a short stem.

h. special basal fragments: n = 1
This tool fragment, made on a secondary b fragment has a narrow straight base, 1 bifacially retouched edge at an obtuse angle, and a notch at the other base corner. The rest of the latter edges are also bifacially retouched.

i. unfinished basal fragments: n = 2
One was made on a flake; the other contains cortex on the base and 1 edge.

2. top fragments
   a. biface fragments where the point forms an angle of 90^0
      1) large fragments: n = 4 (2 burned)

   b. biface fragments where the point forms an angle less than 90^0
      1) small fragments: n = 15 (3 burned)
      Two fragments were made on flakes.

      2) large fragments: n = 22 (4 burned)
      One fragment was serrated a little irregularly along its edges. Two fragments were made on flakes, of which one fragment was made on an older patinated secondary b flake. All fragments from this site are carefully retouched.

3. medial fragments
   a. narrow fragments, the maximum width less than 20 mm: n = 8 (3 burned)
   One fragments was made on a flake, and 1 fragment was long and narrow.

b. medium fragments, the maximum width equal to or more than 20 mm and less than or equal to 40 mm: n = 8 (3 burned)
Two fragments were made on flakes; one a secondary b flake. One fragment was very long and narrow.

c. large fragments, the maximum width more than 40 mm: n = 1

4. edge fragments: n = 31 (8 burned)
Four fragments still retain some cortex. All except one fragment come from finished artifacts.

5. unidentifiable fragments: n = 1

XV. Scaled and battered pieces: n = 1
A large and heavy secondary a flake, with triangular cross-section has intensive, scaled bifacial retouch along the whole left edge.

Site 41WM56

I. Scrapers

A. Single endscrapers

In total 43 single endscrapers were recovered from this site, 2 from backhoe trench spoil, 28 from undatable mixed upper levels, and 13 from identified cultural zones.

1. <u>single endscraper on flakes</u>: n = 15 (10 whole)
Ten tools are complete, 2 are fairly badly damaged at the scraper bit, and 3 others are only fragments. Nevertheless, all fragments can still be identified as end scrapers on flake. All tools are made on flakes: 1 natural flake, 2 primary flakes, 8 secondary flakes with more than 50% cortex (53 percent) and 2 tertiary flakes. The Sb flakes are preferred above all other blanks for this scraper subtype.

There is as wide a morphological variation among these scrapers as there is in size. Eight out of 9 whole scrapers were made on the distal end of the flake, the ninth one on the proximal end. All fragments are distal scraperbits also. The scraperbits on all tools are made by regular steep, occasionally oblique, dorsal retouch, rather large for almost all tools. Often the cortex was removed from the bit by the scraper retouch, and in one fine specimen, the cortex was only barely removed. The scraperbit is usually rather narrow, and only a few scrapers have a wide front.

2. <u>single endscraper on a retouched flake</u>: n = 16 (9 whole, 4 burned)
Very closely related to the former category are the single endscraper on a retouched flake, the only difference being that there is additional retouch on the flakes. This category is slightly more abundant than the former, i.e., 16 with 3 from the identified cultural zones and 13 from the mixed upper levels. Nine tools are completely undamaged, 7 are undamaged at the working end of the tools, but the opposite end is missing.

All tools but one are distal endscrapers, as for the endscrapers on flakes without additional retouch, and the tool bit is produced by rather large oblique to steep dorsal retouch. Some specimens are very finely retouched, others are somewhat rough. On several tools, the retouch is a little crushed. One tool could in a way be considered an inverse scraper: it was made on a slightly plunging flake and the natural curve of the flake was used to produce a very steep scraper bit by intensive "ventral" retouch. Most scrapers are medium-sized to small. The only proximal end scraper has also ventral retouch, posterior to the scraperbit retouch. Since the tool is rather severely damaged by plow scars, it cannot

be told with certainty if this ventral retouch was intentional or not.

Additional retouch on all tools consists of more or less regular retouch along at least one of the edges. Almost always there is also some retouch continuing from the scraperbit retouch.

3. <u>single endscrapers with notches</u>: n = 1 (whole)
Also closely related to the former two categories is this distal scraper made on a tertiary flake with 2 lateral adjacent notches on the right edge. The notches are made by ventral oblique medium-sized retouch.

4. <u>denticulated endscrapers</u> : n = 2 (whole)
Two denticulated endscrapers were recovered from this site, one from the mixed upper levels, one from a culturally unidentified zone between the Round Rock and Clear Fork cultural zones. Both are complete specimens.
The tool from the upper levels is a rather roughly retouched secondary tool with less than 50% cortex. The denticulated scraper bit was partially prepared by flat ventral retouch.
The other tool, also made on a Sb flake, is much smaller and has a wide scraper bit; the denticulation is spaced irregularly and retouched dorsally only.

5. <u>shouldered endscrapers</u> · n = 5 (whole, 1 burned)
There are 5 shouldered endscrapers of which 2 were recovered from the mixed upper levels. Only 2 are complete specimens, the other 3 lacking the proximal end of the flake. All three fragments are small. Three are made on tertiary flakes, 1 on a Sa and one on a Sb flake.
Three out of these 5 tools are left shouldered, one is right shouldered. The retouch is in all cases a little less steep on the shoulder area than on the scraper bit.
The fifth tool is a "nosed" scraper, that is, shouldered on both sides of a very narrow scraper bit. In this tool the working edge is not on the axis of the flake on the distal end, but on the left distal corner.

6. <u>transverse scrapers</u>: n = 1 (whole)
The only transverse scraper was manufactured on a Sb flake by very steep and large, but careful, dorsal retouch. One distal corner of the tool is pointed by steep dorsal retouch, and there is also some oblique large dorsal retouch on the proximal end which removed the platform and most of the bulb.

7. <u>inverse scrapers</u>: n = 1(whole)
The blank the only inverse scraper was made on is unidentifiable, but has a very heavy patina on part of its surface. It is probably a reused older flake. The scraper retouch is steep, regular and large.

B. Single sidescrapers

There are 41 single sidescrapers , 26 from undatable mixed upper levels and plough zones, and 15 from identified cultural zones.

1. single sidescrapers on flakes: n = 17 (1 whole, 2 burned)
   There were 17 single sidescrapers on simple flakes recovered from this site, 6 in identified cultural zones, 11 in mixed upper levels and plow zones.

   In contrast to the single endscrapers on simple flake, 16 out of 17 tools are only fragments, although several are out nearly complete. Nearly all scraperbits cover the entire length of the edge, but one has to keep the fragmentary state of vast majority of the tools in mind. One fragment is also distally truncated, and one other fragment has continuing retouch on the proximal end.

   Seven tools are made on tertiary flakes, 7 on Sb flakes, 1 on a Sa flake, 1 on a primary flake, and 1 on a heavy Sb blade. Sidescrapers on the left or right edge are almost equally distributed: 9 on the right edge, 8 on the left.

2. single sidescraper on retouched flakes: n = 15 (6 whole, 1 burned)
   There were 15 single sidescrapers on retouched flakes recovered at the site, 7 from identified cultural levels, 8 from the mixed upper levels. Seven tools are fragments, the 8 others are complete or nearly so. There are several tools that were fractured at one point, but they were subsequently retouched again from the fractured surface. Five tools were made on tertiary flakes, 6 on Sb flakes, 3 on Sa flakes and 1 on a Sb blade. The retouch that formed the scraperbit varies considerably from rather flat oblique to steep retouch, all on the dorsal face. Nine scrapers are left-edge scrapers, 6 are right-edge scrapers.

   The additional retouch, as was the case for the single endscrapers on retouched flake, is usually a marginal more or less continual ventral or dorsal retouch on the non-scraper edge of the tool. In some cases the retouch is more elaborate, and it also occurs that the bulb of the flake has been removed by very large flat ventral retouch.

3. single sidescrapers on backed flakes: n = 2
   The two sidescrapers on backed flakes from the site were found in the mixed upper levels are both made on Sb flakes, and are both fragmentary. For both tools the scraperbit is on the right edge, somewhat bifacially prepared in 1 specimen, possibly also a result of use a certain degree. The retouch for the scraperbit is oblique to steep and rather rough in 1 tool. The backing retouch is also dorsal and in both cases distinctly steeper than the scraper edge.

4. <u>sidescraper with notch(es)</u>: n = 2 (whole)
   Of the 2 side with notches recovered from the mixed upper levels, 1 was made on a Sa flake, one on a Sb flake. Both are complete and undamaged tools. One tool has only a single large notch, located at the proximal part of the right edge, at the end of the scraper bit on the same edge. All retouch is dorsal, with larger and steeper retouch for the notch.
   The other tool has the scraper bit on the left edge, and 1 single and 3 continuous notches on the distal end. All retouch is oblique dorsal and medium-sized.

5. <u>denticulated sidescrapers:</u> n = 5 (4 whole)
   Five denticulated scrapers were recorded at the site, 3 of which came from dated levels, 2 from mixed upper levels. Four tools are complete or nearly so, 1 is a fragment. Four are made on Sb flakes, 1 on a Sa flake. Three are left-side scrapers, 2 right-side. The denticualtion is in none of the tools very pronounced, but quite distinct yet. Only 1 tool has additional retouch, being some very irregular retouch on the non-scraper edges and the removal of the bulb by large flat ventral retouch.

6. <u>rabot or "keel scraper"</u>: n = 1
   The only rabot from this site comes from the plow zone and is made on a Sb flake. The scraper bit is located on the left edge and is steeply retouched by large dorsal retouch. The profile of the scraper bit is rather strongly curved, due to the natural curve of the flake. The opposite edge is finished by a few very large retouch. The proximal edge is finely retouched to remove the bulb and platform.

C. Double scrapers

There are 19 double scarpers, 15 unfortunately come from the mixed upper levels, while only 4 come from datable levels.

1. <u>double endscrapers</u> : n = 1 (whole)
   The only double endscraper recovered from the site, found in the mixed upper levels, was made on a Sb flake. Both scraper bits are nearly complete, although both edges of the tool are damaged, posterior to the production of the tool.

2. <u>double sidescrapers</u> : n = 5 (4 whole)
   Double sidescrapers were more numerous at this site, i.e., 5 specimens were found, 2 on primary flakes, 1 on a Sa flake and 2 on Sb flakes. Only 1 tool is fragmentary; 1 specimen with many plow-scars is heavily patinated on the nonretouched surface. The distal end of this last tool is pointed and bifacially retouched. Two tools have a partial ventral preparation.

3. <u>double sidescrapers , atypical</u>: n = 2 (whole)
These two tools are both from mixed upper levels, one is manufactured on a Sb flake, 1 on a tertiary flake. These two tools were kept separate from the other double side scrapers because their scraperbits do not, as in the previous category, occupy a whole or nearly whole edge, but are more or less restricted to the upper distal corners of the flake. Both tools have very little other retouch than the scraperbits.

4. <u>single end and single sidescrapers</u> : n = 12 (8 whole, 3 burned)
There are 12 single end and single sidescrapers , 9 from the mixed upper levels, 3 from datable levels. Five tools were made on tertiary flakes, 4 on Sb flakes, 2 on Sa flakes, and 1 on an older tool, meaning that an older heavily patinated tool, probably also a scraper, was used again. Part of the dorsal and ventral surface and part of the retouch have a heavy white patina.

   Eight tools have a scraperbit on the distal end and the left edge, 1 a scraperbit on the proximal end and the left edge, and 3 a scraperbit on the distal end and the right edge. Eight tools are complete or nearly so, 3 others are only fragments. Almost all tools have a fairly strongly convex scraperbit, a few are nearly straight. One specimen has both scraper edges meeting into a blunt point.

   One tool has only very little retouch to form the scraper edges and uses mainly the natural curve and steepness of the flake.

   Only in 3 cases was some ventral retouch employed, in all cases to eliminate the bulb at least partly. One of the small fragments was made in a coarse flint, very different from the much finer usual flint, both in color and in texture.

D. Multiple scrapers: n = 7 (whole)

Seven multiple scrapers were recovered from the site, 5 from the mixed upper levels, 2 in the Round Rock cultural zone. Five were made on Sb flakes, 1 on a tertiary flake and 1 on a biface fragment. This last tool is the only scraper in this site that reused a bifacially retouched artifact. Only one of these scrapers is a quadruple scraper, all others are triple, with 2 side-scraperbits and 1 end scraperbit. Also, the scraperbits are more or less connected with each othe, , except in 2 cases. One of the latter specimens has its 2 side scrapers arranged in a way that remembers the "atypical double side scraper" category.

E. Other scrapers

1. <u>'giant' scrapers</u>: n = 9 (9 whole)
Nine of these artifacts were found, 5 in datable levels, restricted in this site to the Round Rock/Clear Fork and San Geronimo levels, the giant scraper in the latter level being the only scraper recovered in this time zone at this site. The 4 others were recovered from the mixed upper levels and plow zone. Two are made on very large natural flakes, 1 on a primary flake, 2 on Sa flakes, 2 on Sb flakes and 1 on a tertiary flake. Of course, the 2 natural flakes cannot be oriented; they both have 1 large, slightly curved scraper edge. One specimen has additional irregular bifacial retouch on the 2 other edges. Two other tools are made on the left edge, of which one is made on a long flake with a natural steep cortex back. The other specimen is note worthy for exceptional fine dorsal retouch with flat fine ventral retouch on a very straight scraper edge.

   All other 5 specimens have the scraperbit on the right edge, and as was the case with the above tools, with a straight or only slightly curved scraper edge. One tool has a very distinct ventral preparation by very large and flat ventral retouch. One of these tools is an inverse scraper, i.e., with a scraperbit produced by ventral retouch.

2. <u>core scrapers</u>: n = 7 (6 whole)
Seven core-scrapers were found, of which 4 were found in the mixed upper levels. The 3 other ones were fourd in the Clear Fork levels of the site. All corescrapers except one have only a single scraper edge made on 1 of the former core platforms. The double core scraper used a core with 2 opposite platforms on the same face, both of which were very finely retouched. Some of the platforms are finely retouched, others are slightly crushed. One other shows first signs of battering.

E. Fragments: n = 25 (9 burned)

Twenty-five scraper fragments were found, all too fragmentary to be included in one of the above categories. Eleven come from mixed upper levels and plow zone, 14 from the cultural levels.

Five small fragments are burned. Four large fragments and 5 very small fragments are results of normal fractures. Three fragments are distal ends of plunging flakes and so most probably knaping accidents. But there are 8 fragments that are scraper resharpening spalls. Three different methods could be distinguished.

- Renewal of the scraper edge by a blow <u>above</u> the scraperbit on the dorsal face: 1 specimen
- Renewal by a blow on the ventral face, i.e., on the flat part of a scraper, <u>under</u> the scraping edge: 2 specimens

- Renewal by a sidelong blow on the scraper end: 5 specimens, 3 of which are fragments

All three different methods removed a large part of the scraping end, but method #2 also removed a large part of the flake itself, while especially method #3 only removes thin slivers resembling burin spalls.

II. Denticulates

A. Denticulated pieces

1. denticulated only: n = 20 (10 whole, 2 burned)
The denticulated flakes are rather large, and all but 5 fragments were made on Sb or Sa flakes. Nine tools are denticulated on the right edge only, 3 on both edges, 5 on the left edge, 2 on the distal end, and 1 on the proximal end. Some of these tools are very roughly and irregularly retouched. One of the tools denticulated on both edges is alternately retouched.

2. with additional retouch: n = 6 (4 whole)
Three tertiary flakes, 2 Sb flakes and 1 Sa blade were denticulated in all but 1 case by dorsal retouch. The additional retouch usually occurs on the opposite edge, and is mostly a partial backing of the edge by small dorsal or ventral retouch. A very large and heavy tertiary flake has the opposite edge retouch by large flat and irregular retouch.

3. with ventral preparation: n = 3 (1 whole)
The one complete heavy tertiary flake is denticulated over only a small part of its right edge, and prepared ventrally by flat retouch. The rest of the tool is not modified. Both fragments are more extensively denticulated, one of which was only partially ventrally prepared.

B. Fragments: n = 6

Two fragments are cortex flakes, others are tertiary; all are fragments of dorsally denticulated tools.

III. Notched pieces

A. Single notches on flakes

1. single notch only: n = 32 (18 whole, 4 burned)
The majority of the single notched pieces was made on tertiary flakes and secondary b flakes. Only 2 were made on Sa flakes. A nearly equal amount is made by dorsal (15) as by ventral (16) retouch. There seems to be no pattern in the location of the notches, distributed more or less equally over both left and right edges and distal ends. No notches occur on proximal ends. One partially patinated fragments of a flake has a large, carefully bifacially retouched notch.

2. with additional continuous retouch: n = 20 (2 whole, 5 burned)
   Ten tools were made on tertiary flakes, 5 on Secondary b, and 4 on secondary a flakes, the majority of them notched by dorsal retouch. Usually, the notch is on one edge, and the additional retouch is a regular, mostly dorsal, small oblique marginal retouch on the other edge; or the notch is on the distal end, and more retouch is located on 1 of the edges. There is only 1 flake with notch and retouch on the same edge and 1 tool where the additional retouch is bifacial on both edges.

3. large and crude notched tools: n = 1 (whole)
   A very large secondary a flake has a ventrally retouched notch in its left edge, with irregular and crude additional retouch on the same edge and the distal end.

B. Multiple notches on flakes

1. non-adjacent notches: n = 10 (5 whole, 2 burned)
   Two secondary a, 3 secondary b, and 5 tertiary flakes have multiple non-adjacent notches, both ventrally and dorsally retouched, on both edges and distal end.

2. occasionally adjacent notches: n = 14 (4 whole, 2 burned)
   Two whole Sb flakes, 1 whole tertiary flake, and 2 fragmentary Sa flakes have 1 pair of adjacent dorsally retouched notches. All other notches on these 5 tools are dorsal, too.

   Three tertiary, 1 Sb and 2 Sa flakes ahve 2 adjacent dorsally retouched notches, without any further modification on the rest of the flake fragments. One tertiary and 1 Sb fragment have ventrally retouched notches.

   A tertiary core trimming element has 2 ventrally retouched notches proximal on its left edge, and some further dorsal retouch along the same edge.

3. adjacent notches, alternating retouch: n = 1 (whole)
   A secondary b flake has 2 adjacent notches on its right edge, and is further unmodified.

4. large and crude pieces: n = 3 (1 whole, 1 burned)
   Two large tertiary chunks (or flakes) and 1 heavy Sa fragment have large, mainly ventrally retouched notches. All notches are made by only few large retouch.

C. Notched blades, bladelets and microblades

1. multiple notches: n = 3 (whole, 1 burned)
   Two tertiary and 1 Sa blade have multiple non-adjacent dorsally retouched notches spread over both their edges. Two blades are rather severely damaged.

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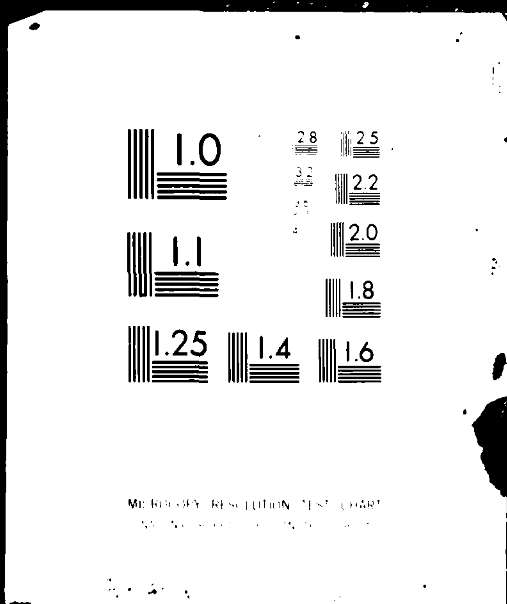
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D. Other

1. meganotch: n = 3 (2 whole)
   Two whole large Sb flakes have a carefully dorsally retouched large notch on one edge, with no other retouch. A tertiary flake fragment has the notch on its distal end, also made by carefully dorsal retouch.

2. alternatingly retouched notches: n = 6 (1 whole, 1 burned)
   All five fragments have 2 notches, 1 on each edge at equivalent loci, but one is retouched dorsally, the other one ventrally. Four fragments are tertiary, 1 is a Sb fragment.

   The sixth tool was made on a Sb flake, the alternatingly retouched notches close to the proximal end, with continuing ventral retouch on both edges. There is also a large distal notch, with intensively scaled dorsally retouch.

3. strangulated pieces: n = 3 (1 whole, 1 burned)
   Two secondary b flakes and 1 tertiary flake are strangulated all by dorsally retouched notches, rather deep in 2 tools, shallow and not entirely parallel with each other for the third tool.

E. Fragments: n = 13 (6 burned)

All fragments are Sb and tertiary fragments, mostly hard to identify. All have a part of a dorsally retouched notch.

IV. Boring Tools

A. Gravers

1. gravers on the flake axis: n = 5 (3 whole, 1 burned)
   Two sharply pointed gravers, both made on tertiary flakes, were made by steep and oblique fine dorsal retouch on the distal end of the flake. The other tool has continuous oblique dorsal retouch on the remainder of both flake edges too.

   Another graver, also made on a tertiary flake, is very similar to the two tools mentioned above, but in this specimen the graver point is more elongated.

   Another tool is also similar to the above tools, but was made by ventral retouch, on a secondary b flake.

   The last tool, made on a tertiary flake, is similar to the above tools as well, but here the graver point is short and more square. This specimen has some flat, ventral retouch on the left edge.

2. gravers on the flake edge
   a. 'beaked' gravers: n = 4 (1 burned)
      Two gravers were made on secondary b flakes, 2 were made on tertiary flakes. In three tools the graver point is a very pronounced beak, and all were made by steeply, dorsally retouched notches. The fourth tool is slightly damaged on the graver point, and was made by ventral retouch.

   b. 'normal' gravers: n = 1
      One graver on flake edge is a normal graver, made on a tertiary flake by steep ventral retouch.

3. oblique gravers: n = 5 (4 whole, 1 burned)
   Two oblique gravers were made on secondary b flakes, 1 on a tertiary flake. Two have their graver point on a distal end corner, and were made by steep dorsal retouch. The third tool is ventrally retouched, and is located on a proximal end corner.

   Two other gravers closely resemble the ones mentioned above, but they have a heavier, stronger point, with a triangular cross-secion. One was made on a secondary b flake, the other one on a tertiary flake.

4. unidentifiable fragments: n =1
   One graver fragment was made on a cortex flake, (Sb?). It is possible that this tool was another 'beaked' graver on the edge of a flake, made by ventral retouch.

B. Borers

1. borers on the flake edges: n = 1
   This tool is a borer made on the edge of tertiary flake, formed by oblique ventral retouch from the distal part, dorsal from the proximal part of the flake. The tool also has continuous oblique dorsal retouch on most of the left edge.

2. oblique borers: n = 2 (whole, 1 burned)
   These two oblique borers were made on a tertiary and a secondary b flake, the latter one of which is burned. Both tools have extensive additional retouch on the edges.

C. Perforators

1. perforators on flake axis: n = 1
   This tool was made on the distal end of a tertiary flake, and retouched by oblique bifacial, almost covering retouch on both edges of the flake. The proximal end of the tool is missing.

D. Drills

1. drills on pointbase: n = 6 (2 whole, 1 burned)
Six drills were made on winged point bases

2. drills on bifacially retouched base: n = 4 (2 whole)
Four other drills have a bifacially retouched base, the retouch always completely covering. One tool has a small basically triangular base, 2 have roughly rectangular lying bases, and one has a rectangular standing base. This latter tool is one of the finest tools recovered from the site.

3. unidentifiable fragments: n = 10 (5 burned)
All fragments are drilbit fragments, a large amount of them was damaged by fire.

E. Other

1. 'picks': n = 4 (2 whole, 1 burned)
Four tools have a heavy, pointed, more or less elongated boring bit. Two are made mainly by bifacial retouch, not only on the bit, bit also on most of the tool body. Both retain some cortex, and one was burned. Another tool was made on the right, pointed edge of a wide flake, by intensive steep dorsal retouch, finished by flat ventral retouch on the point only.

The fourth tool is a unique specimen, made on the proximal end of a large secondary b flake fragment; its distal part is missing. The flake has a perfect conical bulb, that was sharpened by 3 burin-like blows. The right flake edge is naturally steep, the left edge is naturally sharp, with some small irregular retouch. It is not clear without microscopic analysis if the borer point or the sharp flake edge was the working part of the tool, or if they where both used at one point.

V. Truncations

A. Single distal truncations

1. dorsal retouch: n = 14 (10 whole)
Seven flakes were truncated only. The truncati[illegible] straight and also oblique in 3 cases, one of whic[illegible] slightly concave. All but one of these tools were made on secondary b flakes and 1 bladelet; the tenth one was made on a tertiary flake.

Some tools have elaborate retouch in addition to the truncation; two tools were made on tertiary blades, 1 on a flake, and 1 on a secondary a flake. The latter

tool was worked by large crude and irregular retouch. The truncation on the flake has also a very steep basal notch made by perpendicular dorsal retouch; the large blade was retouched very irregularly on both edges. A fourth tool has a very narrow truncation, by dorsal retouch on the distal end, and has steep dorsal retouch continuing down the left edge.

2. <u>ventral retouch</u>: n = 3 (2 whole)
All three tools were made on tertiary flakes by steep small to medium ventral retouch.

B. Single proximal truncation

1. <u>dorsal retouch</u>: n = 7 (3 whole)
Three truncations were made on tertiary flakes, 1 on a tertiary bladelet, one on a Sb flake and 1 on a Sa flake. All truncations are slightly to strongly oblique, in varying degrees light convex to concave. Two tools are also regularly dorsally retouched on both edges, and a third one irregularly by large dorsal and also some ventral retouch. The truncated bladelet was pointed at the distal end by a few small dorsal retouch.

2. <u>ventral retouch</u>: n = 3 (whole)
All truncations were made on tertiary flakes by steep medium to small retouch, two of which are severely damaged by plowing activity.

C. Double truncations: n = 3 (whole)

A large secondary a flake is turncated alternately by steep medium to large retouch, dorsal on the distal end, ventral on the proximal end; both truncated ends are much narrower than the maximum width of the flake. A small tertiary flake is also truncated alternately, but ventral on the distal and dorsal on the proximal end.

A secondary b flake was steeply truncated on both ends by medium to large dorsal retouch.

VI. Backed pieces

A. One whole edge backed

1. <u>straight or slightly convex edges</u>:
   a. dorsal retouch: n = 13 (3 whole, 2 burned)
   Nearly all backed pieces are only partially preserved, in about equal amounts of proximal and distal fragments. Five tools were made on tertiary elements, all others on secondary b flakes.

   b. ventral retouch: n = 1 (whole)
   A small tertiary flake had its right edge backed by regular ventral oblique retouch.

2. <u>convex edge</u>
   a. dorsal retouch: n = 6 (2 whole)
      Two backed tools on tertiary flakes are preserved complete; 3 others, all on Sb flakes, are fragmentary. The sixth backed fragment on a Sb primary burinspall. Three tools are backed on the left edge; 3 on the right.

   b. ventral retouch: n = 1 (whole)
      This unique tool was made by rough and irregular retouch on the right edge of a Sa flake. There is also some irregular crushed dorsal retouch on both the distal end and part of the left edge.

3. <u>concave edge</u>
   a. dorsal retouch: n = 1 (whole)
      A small Sb flake has a steeply backed right edge, slightly concave; the retouch gradually becomes less steep towards the distal end.

B. One edge partially backed

1. <u>dorsal retouch</u>: n = 1
   The proximal part of the left edge of this Sb blade fragment was partially backed by steep small dorsal retouch. It is possible that the right edge was also partially backed, but there is too much damage to the tool to be certain. The blade is snapped at the distal end.

2. <u>ventral retouch</u>: n = 1
   The left edge of a tertiary flake fragment was backed steeply near the proximal end (i.e., fracture); the distal half of the edge is left unaltered.

C. Double backed pieces

1. <u>both edges are straight or slightly convex</u>: n = 5 (1 whole, 2 burned)
   The only whole tool, made on a Sb bladelet was fractured in antiquity and then retouched from the snap on the dorsal face, probably at the same time as the tool was backed. Due to fire damage, the backing on the right edge is not very clearly preserved.

   The other four tools are fragmentary; 2 are distal fragments and 2 are medial fragments. All are backed by large and steep, slightly irregular dorsal retouch. The largest fragment has fire damage but had extensive flat ventral preparation.

2. <u>both edges are concave</u>: n = 2 (1 whole, 1 burned)
   Both these double concave backed tools were made on Sb elements; one on a blade, one on a flake. Both tools were backed by steep regular and large dorsal retouch. The blade has its

deepest concavity near the middle of the tool and so has slightly strangulated appearance. The other tool is broken at both ends but goes from a maximum width of 43 mm at one end to a minimum width of 15 mm at the opposite extremity.

3. mixed outlines: n = 1 (whole)
Both edges of a Sb blade were partially dorsally retouched on the proximal and medial part of the edges. The left edge is steeply retouched; the right edge more oblique; their outlines are convex and concave, respectively.

D. Other backed pieces

1. cortex backed pieces: n = 2 (1 whole)
One Sb blade and one Sb blade fragment both have a steep cortex covered right edge, while they were retouched on the other edge. In case of the fragmentary tool, this was by irregular denticulated oblique bifacial retouch. For the other tool it was rather small steep dorsal retouch for the medial part of the edge, with some additional retouch from the dorsal rib towards the left edge. Both tools have a heavy triangular cross-section.

E. Fragments: n = 10 (2 burned)

Four fragments are small parts of flake edges, all retouched dorsally; two other fragments are medial parts, 2 are distal parts and 1 is a proximal part. All of these were dorsally backed also. The latter three fragments and 2 of the edge fragments are cortex flakes. The last fragment was made on the right edge of a tertiary bladelet fragment by regular small dorsal retouch.

VII. Burins

The total number of burins at this site amounts to 105 tools. Unfortunately, 49 (or 46.67%) of these were recovered from the surface and backhoe trenches (6 or 5.71%), are from mixed plowzone levels and other mixed levels (43 or 40.95%), and can not be assigned to any cultural zones or levels.

A. Single angle burins

1. on snap: n = 41 (39 whole, 4 burned)
Fifteen angle burins on snap were made on biface fragments. Most of these are single facetted, and only three tools were renewed once. There are a few tools that show that the biface fragment had more than one fracture before it was to be used again as a burin. Also, most fragments originate from well worked bifaces, only three fragments originate possibly from unfinished bifaces (or points?).

Fourteen single angle burins on snap were made on point fragments. Nearly all of these tools occur on a snap in the blade of the point, the fracture plane subsequently being used as a platform for the burin spall. There are three fragments where the blade fractured very close to the stem; one of these fragments was used in a different way, i.e., one of the base corners was snapped, and the burin blow was given from there.
Only three burins show renewal, and most burins were single facetted. One triangular point (or biface?) was also re-used as a burin.

Twelve single angle burins on snap were made on flakes, 2 on secondary a flakes, 6 on secondary b flakes and 4 on tertiary flakes. Five tools were renewed at least once; three were made by multiple facets, 4 were single facetted. Only three of these burins on flake show additional retouch. One tool has been roughly and irregularly retouched by oblique medium to large dorsal retouch on the right edge. Another tool was retouched by steep medium large dorsal retouch on the dorsal end, which could be either a truncation or an endscraper, unfortunately this part of the tools had been severely damaged by recent retouch, so the function of that part remains unclear. The third tool has continuous fine ventral retouch on the same edge where the burin scars occur, and larger less careful retouch elsewhere.

2. <u>on truncation</u>: n = 3 (2 whole)
   One single angle burin was made on a slightly concave truncation on a tertiary flake; the burin was single facetted. The truncation was made by small steep ventral retouch.

   Two other single angle burins were manufactured on a straight truncation. For both tools the truncation retouch is steep, large dorsal retouch, and both were made on secondary a flakes.

3. <u>other</u>: n = 5 (whole)
   There are five angle burins which were not made on truncation or on snap. All were made on flakes, 1 tertiary flake, 1 secondary a flake, and 3 secondary b flakes. Three tools are multiple facetted burins, 2 are single facetted, none were renewed. Two tools have some additional retouch along 1 edge.

   One tool is also notched.

B. Double angle burins

1. <u>on one extremity, opposed edges</u>: n = 11 (8 whole, 1 burned)
   Eleven double angle burins on 1 extremeity were recovered from this site, five only of which could be dated.

Eight out of eleven tools were made on bifacially retouched fragments, or 4 biface fragments and 4 projectile point fragments. All 4 burins on biface fragments were called 'angle burins', although the original orientation of the biface could not be distinguished with certainty in all cases.

The burins on point fragments were all made on snap's, close to the point stem, with one exception only. The latter one snapped close to the point of the projectile point, but the long burin scars reach all the way to the point stem. One tool was made on a double fracture in the point blade, where the two fractures in themselves form a wide angle.

Two tertiary flakes and one secondary flake fragment were also used. One tool was severely damaged and/or retouched again after the burin was made, but the damage by plowscars is very extensive.

Almost all burins are single facetted, but several were renewed (14). In only one of the tools one burin bit was multifacetted.

2. <u>on two extremeties, one edge</u>: n = 1 (whole)
   One double angle burin was made on a secondary b flake, snapped on both extremities, but with the burins made on same edge. One burin bit is multifacetted, the other one is single facetted.

3. <u>on opposed extremities and opposed edges</u>: n = 2 (whole)
   One of these tools was made on a biface fragment, the other one on a secondary b flake. Both tools have one multiple facetted and one single facetted burin.

C. Dihedral burins

1. <u>dihedral burins on angle</u>: n = 14 (whole, 1 burned)
   Biface fragments were used to produce 6 of these burins, and all tools except one are at least on one side multiple facetted. One artifact is quite strongly pecked (or crushed) on the burin bit, the burin scar and the upper part of one face.

   All the other dihedral burins on axis were made on flakes, i.e., 6 tertiary flakes and 2 secondary b flakes. It is interesting to note that all these flakes are heavy and large, more so than the average flakes. A very large, heavy and crude secondary b flakes has some interesting red and yellow discoloration and strikingly glossy spots on the dorsal surface which are probably due to patination. Also, part of the bulb and the platform of this flake were removed by large, ventral oblique retouch.

As was the case for the dihedral burins made on biface fragments, almost all tools had at least one burin bit made by multiple burin spalls.

2. <u>dihedral burins on axis</u>: n = 4 (whole)
Three dihedral burins on axis were made on flakes, 2 secondary b flakes and one tertiary flake. One tool has its working end on the proximal end of the flake, and was single facetted. The other tool was multiple facetted on one side. The third burin on flake was a crude dihedral burin, also on the proximal extremity of the flake. It has also some large dorsal denticulated retouch on the left edge.

3. <u>atypical (or reversed) dihedral burins</u>: n = 4 (whole)
This burin type has not been previously reported. For this tool, first a normal burin is produced; this can be an angle burin on snap (2 specimen) or a dihedral burin (2 specimen). Then another burin is produced, using as a striking platform the distal end of the burin scar produced in the first step.

Two of these tools were made on biface fragments, 1 on a point fragment, and one on a heavy secondary b flake. All were made by multiple facets.

D. Transversal burins

1. <u>single transversal burins</u>: n = 5 (whole)
There are 5 single transversal burins, 4 made on secondary flakes, 1 on a tertiary flake. Four of these burins have no prepared burin platforms, but were struck from a facet that was previously present (3 specimen) or on a natural cortex facet (2 specimen). Three burins have a crushed working end.

2. <u>double transversal burins</u>: n = 1 (whole)
One double transversal burin was recovered from this site, of which both burin bits were made from unprepared platforms. One was single facetted, the other one was multiple facetted, where the burin scars blend into flat to oblique large ventral retouch. This burin resembles a 'burin plan' quite closely.

E. Oblique burins: n = 2 (whole)

One tool is a single facetted oblique burin on snap. The other tool is quite exceptional. It was made on a secondary a blade, alternately retouched by flat medium to large ventral retouch on the proximal half of the right edge, and fine regular oblique medium to large dorsal retouch, starting halfway on the left edge up to the end of the burin scar. The platform for the burin was unprepared, and the tool was renewed once.

F. Multiple burins: n = 8 (whole, 1 burned)

Five burins were made on flakes, 2 on tertiary flakes, 3 on secondary b flakes. Three of the tools were retouched prior to the production of the burins. Two biface fragments were also re-used as burins, and so was a point fragment.

All tools have 2 or 3 working end, varying from burins on snap to dihedral burins, to burins from a retouched edge. Most burins are single facetted, but some are multiple facetted. Few tools were renewed.

G. Unidentified fragments: n = 3

This category contains those burins that could not be classified with any other burin type, mainly because of their fragmentary state of preservation. As far as could be observed, all three tools were made on flakes, 2 on tertiary flakes and 1 on a secondary a flake.

VII. Composite tools: n = 10 (whole, 2 burned)

Six tools are scraper-burin combinations; five tools are partially sidescrapers, one of which a denticulated one, and the burins are twice transversal, once double (i.e., on both extremities), and three times single angle burins, one from a snap, one from a natural cortex platform on the distal end, and one from a concave truncation of the proximal end.

One was made on a tertiary flake (or blade) with an endscraper on the proximal end, and a transversal burin, from an unretouched edge, on the other end.

One tool is a scraper-borer combination made on a large tertiary flake. The scraper is an end and sidescraper on the right edge with the borer on its left edge, by steep alternating retouch.

Another tool, made on a Sa flake is a scraper-graver combination: there are 2 scraperbits, one on each edge, very regularly dorsally retouched. The graver is an oblique one on the distal end, equally very carefully dorsally retouched.

The last two tools are burin-graver combinations, one made on a tertiary flake, one on a Sb flake. The former is a transversal burin from a ventrally retouched edge, the graver made by dorsal retouch on the same edge. The latter is a dihedral burin on angle, the middle of the opposed left edge has a sharp dorsally retouched beaked graver.

IX. Retouched pieces

A. Pieces with unilateral retouch

1. dorsal retouch

a. retouched edge

1. nearly entire edge: n = 83 (17 whole, 23 burned)

The complete tools are:

made on		ret. left edge	right edge
tertiary flake	10	8	2
tertiary blade	2	2	-
Sb flake	4	1	3
Sa flake	1	-	1
Sa blade	1	-	1
		11	7

Retouch for these pieces is usually oblique to steep small retouch; only in 2 cases is the retouch larger, in both cases because of the large flakes. The retouched edge is always nearly straight or slightly undulating.

The fragments are:

made on		ret. left edge	right edge	?
tertiary flake	43	21	19	3
tertiary blade	1	1	-	-
Sb flake	17	13	4	-
Sb blade	1	1	-	-
Sa flake	3	2	1	-
		38	24	3

Several of the fragments are certainly parts of other tool categories, but are too fragmentary to be identified as any of those with certainty. Therefore the variety in the fragments is much greater than among the whole pieces. For this site, this variety lies in the retouch size, the retouch angle, as well as in the outline of the retouched edge.

2. less than half the edge: n = 5 (whole)

There were no fragments from this retouched piece group found at this site. The complete tools are:

made on		ret. left edge	right edge
tertiary flakes	2	1	1
tertiary microblade	1	-	1
Sb flake	1	1	-
Sb bladelet	1	-	1
		2	3

Four flakes were partially retouched near the dorsal extremity 1 from the proximal end. The retouch is oblique, from small to medium sized.

b. retouched end

1. proximal end: n = 1
   A fragment of a Sa flake is very irregularly retouched on the proximal end, partially damaged too.

2. distal end: n = 21 (11 whole, 4 burned)

made on		whole	fragment
tertiary flake	12	8	4
Sb flake	5	2	3
Sa flake	4	1	3
		11	10

Usually the distal retouch is small and oblique, but a few flakes have a larger and steeper retouch, others more flat. None of these could be classified into another tool type, although some of the fragments may be so.

2. ventral retouch

a. retouched edge

1. nearly entire edge: n = 36 (11 whole, 3 burned)
   The complete tools are:

made on		ret. left edge	right edge
tertiary flakes	5	2	3
Sb flakes	6	2	4
		4	7

The retouch in this tool category for the whole flakes varies greatly, from irregular large flat retouch to small oblique continuous along a whole edge.

The fragments are:

made on		ret. left edge	right edge	?
tertiary flakes	21	9	11	1
Sb flakes	2	-	2	-
Sb blade	1	1	-	-
Sa flake	1	1	-	-
		11	13	1

Most fragments have a fine oblique continuous retouch along 1 edge. Few fragments have large flat retouch.

2. less than half edge: n = 3 (whole, 1 burned)
These complete tools are:

made on	ret.	left edge	right edge
tertiary microflake	1	1	-
tertiary blade	1	-	1
Sb bladelet	1	1	-
		2	1

All three fragments are retouched on the proximal part of the edge.

b. retouched end
1. proximal end: n = 2
Two tertiary flakes were flaked by few flat ventral retouch, removing part of the bulb and the platform. One flake is slightly crushed in a small part of the dorsal face as if it was used shortly as a hammerstone.

2. distal end: n = 4 (2 burned)
Three heavy Sb flake fragments and tertiary fragments were all rather irregularly obliquely retouched by medium to large retouch.

3. bifacial retouch
a. retouched edge
1. nearly entire edge: n = 8 (1 burned)
These fragments are:

made on	ret.	left edge	right edge
tertiary flakes	5	4	1
Sb flakes	4	2	2
		6	3

2. less than half edge: n = 2 (1 burned)
A heavily fire damaged tertiary flake and a large Sa flake were both bifacially retouched along their left edge.

b. retouched end
1. proximal end: n = 1 (burned)
The proximal end of a wide, large Sb flake was irregularly bifacially worked.

4. alternating retouch
a. retouched edge: n = 13 (6 whole, 1 burned)
The complete tools are:

made on	ret.	left edge	right edge
tertiary flakes	2	2	-
tertiary blades	1	-	1

Sb flakes	2	2	-
Sa blade	1	1	-
		5	1

Most tools have elaborate medium to large flat/ oblique retouch, only the tertiary blade has small retouch.

The fragments are:

made on		ret. left edge	right edge
tertiary flakes	4	2	2
Sb flakes	1	-	1
Sa blades	2	-	2
		2	5

These fragmentary tools were retouched by smaller retouch than the complete ones. Both blade fragments are very well made, long and narrow, but both miss 1 extremity.

5. other retouch - mixed bifacially and unifacially
   a. retouched edge: n = 6 (2 whole, 2 burned)
      The Sb flakes are retouched by mainly unifacial retouch, with a small part of the edge bifacially retouched. One flake is retouched on the right edge by large irregular retouch, the other tool was retouched finely on the left edge.

      The fragments are:

made on		ret. left edge	right edge
tertiary flakes	1	1	-
Sb flakes	1	-	1
Sa flakes	2	2	-
		3	1

6. discontinuing retouch
   a. retouched edge: n = 3 (1 whole)
      One whole Sb flake has some dorsal retouch, and few ventral retouch on the right edge. There are 2 more tertiary fragments with retouch on the right side.

B. Pieces with bilateral retouch

1. dorsal retouch
   a. 2 retouched edges
      1. 2 nearly entire edges: n = 17 (3 whole, 5 burned)

The tools were:

made on		whole	fragments
tertiary flakes	10	2	8
Sb flakes	4	0	4
Sa flakes	3	1	2
		3	14

The retouch on these tools nearly always small and steep to oblique. Only very rarely (2 times) is the retouch medium-sized. The retouch normally follows the flake outline, and is most often slightly convex.

2. 1 nearly entire edge and 1 edge partially: n = 6 (4 whole)
   All tools were on tertiary flakes, mostly with small oblique to steep retouch, sometimes with medium retouch. The edges are slightly convex or slightly concave. For the complete pieces, the partially worked edge is always retouched medial towards the distal end.

3. 2 edges partially, equivalent loci: n = 3 (2 whole)
   One tertiary and 1 Sb flake were partially retouched, near the proximal and distal ends respectively. A tertiary fragment has medium to large regular retouch, but the tool is very fragmentary.

b. 1 edge and 1 end retouched
   1. both partially: n = 4 (2 whole, 1 burned)
      These tools were:

made on		whole	fragments
tertiary flakes	1	-	1
Sb flakes	2	2	-
Sa flakes	1	-	1
		2	2

Always the distal end is retouched, with one edge, never the proximal end.

2. both nearly entirely retouched: n = 22 (5 whole, 4 burned)
   The tools were:

made on		whole	fragments
tertiary flakes	11	-	11
Sb flakes	6	2	4
Sb bladelets	1	1	-
Sa flakes	4	2	2
		5	17

Of all the whole flakes, 1 is retouched on the proximal end, the others on the distal end. There is also one of the fragments that was retouched on the proximal end.

2. ventral retouch
   a. 2 retouched edges
      1. 2 nearly entire edges: n = 6 (1 whole, 1 burned)
         These tools were:

made on		whole	fragments
tertiary flakes	4	-	4
Sb flakes	1	1	1
		1	5

         All the tertiary fragments were retouched by small oblique or steep retouch. A large Sa flake was flaked by few very large flat retouch, covering nearly the whole ventral surface.

      2. both edges partial, unequivalent loci: n = 1 (whole)
         One edge of this tertiary flake was retouched proximal, the other one medial and distal.

   b. 1 edge and 1 end
      1. both nearly entirely retouched: n = 6 (1 burned)
         These fragments were made on: tertiary flakes 3, Sb flakes 2, and Sa flakes 1.

         Some fragments are finely worked by small oblique retouch, others are less regularly worked, with large oblique to flat retouch.

      2. 1 whole, 1 partially retouched: n = 1 (whole)
         A very large and heavy Sa flake was flaked by large flat ventral retouch on the proximal end, and few large retouch near the distal end on the left edge. Possibly this tool is some kind of chopping tool.

3. <u>bifacial retouch</u>
   a. 2 touched edges: n = 2 (burned)
      These tools were made on a large Sb flake and a small tertiary flake by large and small retouch, respectively.

4. <u>alternating retouch</u>
   a. 2 edges, 1 retouched alternatingly: n = 6 (2 whole)
      These tools were:

made on		whole	fragments
tertiary flakes	3	-	3
Sb flakes	3	2	1
		2	4

A very large Sb flake was retouched by medium and large oblique retouch, the other tools by small retouch.

b. 1 edge alternatingly, 1 end retouched: n = 1
This tool fragment is made on a Sb flake, with large flat and steep retouch. This is probably a fragment of an unidentifiable tool.

c. 1 end alternatingly, 1 edge retouched: n = 1 (whole)
A tertiary tool was retouched by small oblique retouch.

5. alternate retouch
   a. 2 edges
      1. 2 nearly entirely retouched edges: n = 20 (3 whole, 4 burned)
         These tools were:

made on		whole	fragments
tertiary flakes	17	2	15
Sb flakes	3	1	2
		3	17

The retouch used for all tools is very uniform, i.e., a small, usually oblique retouch, sometimes steep. On nearly all tools the retouch covers both edges completely, although most are fragments. The edge outline is mostly straight or slightly convex, although sometimes rather irregular.

      2. 1 edge partially, 1 entirely retouched: n = 6 (2 whole, 1 burned)
         These tools were:

made on		whole	fragments
tertiary flakes	2	-	2
Sb flakes	3	1	2
Sb blades	1	1	-
		2	4

All were made by small oblique retouch, more or less regular on both edges.

      3. both edges partially retouched, equivalent loci: n = 6 (4 whole, 1 burned)
         The tools were:

made on		whole	fragments
tertiary flakes	3	2	1
tertiary blades	1	-	1
Sb flakes	1	1	-
Sb blades	1	1	-
		4	2

Only 1 complete tool was retouched on the proximal part of both edges, all others were retouched on the medial part.

4. both edges partially retouched, unequivalent loci: n = 4 (1 whole)
   These tools were:

made on		whole	fragments
tertiary flake	3	1	2
Sb flake	1	-	1
		1	3

   The complete tertiary flake is retouched by medium oblique retouch, very regular on 1 edge.

5. double alternate: n = 1
   This tool was made on a Sb flake by irregular small retouch.

b. 1 edge and 1 end: n = 13 (6 whole, 2 burned)
   The tools were:

made on		whole	fragments
tertiary flakes	6	3	3
Sb flakes	6	2	4
Sa flakes	1	1	-
		6	7

   Most of these tools were retouched by small oblique to steep retouch, a few flakes by steep medium to large retouch. Overall, most pieces are regularly flaked.

c. 2 ends: n = 1
   A recently damaged Sb flake was retouched on both ends by steep medium, not very regular retouch.

6. <u>other</u>
   a. mixed bifacial and unifacial retouch
      1. 2 retouched edges: n = 10 (3 whole, 1 burned)
         These were:

made on		whole	fragments
tertiary flakes	4	-	4
Sb flakes	6	3	3
		3	7

      2. 1 edge and 1 end: n = 11 (2 whole, 1 burned)
         These tools were:

made on		whole	fragments
tertiary flakes	4	1	3
Sb flakes	5	1	4
Sa flakes	2	-	2
		2	9

b. discontinuous retouch
   1. 2 edges: n = 2 (1 whole)
      Both tools were made on secondary elements, 1 on a fragment, the other one on a blade.

   2. 1 edge and 1 end: n = 2 (whole, 1 burned)
      Two large and heavy Sb flakes were used for these tools, both made by medium to large irregular retouch.

C. Multilateral pieces

1. dorsal retouch: n = 3
   All tools were fragments:

made on		whole	fragments
tertiary flakes	1	-	1
Sa flakes	2	-	2
		-	3

   The retouch on the tools is oblique small to medium retouch.

2. ventral retouch: n = 1 (burned)
   This small fragment was made on a Sb flake.

3. bifacial retouch: n = 1 (burned)
   This tool fragment was made on a heavy Sb flake.

4. mixed bifacial and unifacial retouch
   a. 2 edges and 1 end
      1. 1 end bifacially retouched: n = 4 (1 whole)
         These tools were:

made on		whole	fragments
tertiary flakes	3	-	3
Sa flakes	1	1	-
		1	3

         All tools were retouched by large oblique retouch, bifacial twice on the proximal end, twice on the distal end.

      2. 1 edge bifacially retouched: n = 1 (whole)
         A large, heavy Sa flake was retouched partially over 3 edges, by medium to very large flat or oblique retouch, mainly on the ventral face.

   b. all ends and edges retouched: n = 2 (whole)
      A tertiary flake was partially bifacially, partially ventrally or dorsally retouched along its margins. The flake outlines are irregular, possibly intentionally so. The second tool is subcircular, made on a natural

Sa flake, by very large and flat ventral, oblique medium to large dorsal retouch. The ventral retouch is partially covering.

5. mixed unifacial retouch
   a. 2 edges and 1 end: n = 14 (4 whole, 2 burned)
   These tools were:

made on		whole	fragments
tertiary flakes	13	4	9
Sb flakes	1	-	1
		4	10

   Retouch generally is very irregular, and very scattered also in certain cases. Some fragments are possibly fragments of other tool types, but all are too fragmentary to be identified as such.

6. discontinuous retouch: n = 7 (4 whole, 3 burned)
   These tools are:

made on		whole	fragments
tertiary flakes	2	-	2
Sb flakes	4	3	1
Sb blade	1	1	-
		4	3

   One large complete Sb flake is very irregularly retouched but also nearly completely covered by ventral retouch.

D. Special retouched pieces

1. pointed flakes and blades: n = 7 (1 whole, 1 burned)
   These tools were:

made on		whole	fragments
tertiary flakes	2	-	2
Sb flakes	3	1	2
Sa flakes	2	-	2
		1	6

   All were carefully retouched, mainly by regular dorsal retouch. Some are probably fragments of now unidentifiable tools.

   Four fragments have a pointed part that is not located on the flake axis.

2. <u>pieces with triangular, sharp cross-section</u>: n = 1 (whole)
   A heavy Sb blade was retouched, dorsally by few large steep retouch from both edges, and there were also some large flakes detached from the dorsal rib towards the left edge. It is possible that the flake was a core trimming element.

3. <u>other</u>: n = 4 (1 whole)
   The complete tool was made on a large Sb flake, retouched by steep or oblique dorsal retouch on the distal end, but tilted at an obtuse angle so as to give this part of the tool a triangular cross-section. Another tertiary fragment has very steep to perpendicular large dorsal retouch, pointed to a sharp point; the other face was prepared by flat retouch. The original tool type this fragment belongs to could not be identified.

   A third thin tertiary flake fragment was retouched on the left edge by oblique to flat dorsal medium retouch. There is a slight shine on both dorsal and ventral face along the flake edge.

   Another tool was made on a tertiary flake, elaborately retouched on all edges, especially the left which was intensively bifacially retouched. The distal end of the flake is very sharply pointed, and the proximal end is notched twice, non-adjacent, giving the impression of a short stem. This proximal end was totally bifacially retouched, partially covering.

E. <u>unidentifiable fragments:</u> n = 297 (56 burned)
   <u>These fragments were made</u> on:

tertiary flakes	194	primary flakes	2
tertiary blades	2	BTF	3
Sb flakes	62	natural flakes	1
Sb blades	8	chips	6
Sa flakes	14	chunks	5

X. Bifaces

A. Small bifaces, triangular and subtriangular

1. <u>with a concave base, thick in cross-section</u>: n = 1
   A small triangular biface with a light concave base was recovered from this site. The tool is relatively thick but was carefully bifacially retouched. The only similar tool was recovered from site 41WM53 units   in Austin/ Twin Sister transition context.

2. <u>with a straight or slightly convex base, thick in cross-section</u>: n = 1
   Excavated from mixed upper levels was this small, relatvely thick triangular biface, carefully bifacially retouched,

sharply pointed. There is some bifacial thinning at the base of the tool. Although the tool outline is slightly irregular, the secondary bifacial retouch is very fine.

3. with a strongly convex base, thick in cross-section: n = 2 (1 burned)
   The two small subtriangular bifaces with convex base recovered from this site are both of uncertain date. One was found in a mixed upper level, the other one may be low to the Round Rock, or Clear Fork component. The latter artifact is slightly damaged by fire and has an accentuated somewhat crooked point; the other biface is patinated white.

4. with a strongly convex base, thin in cross-section: n = 3
   Three thin bifaces with convex base were also recovered from the site. All three are rather irregularly retouched, mainly bifacially, with secondary unifacial retouch only in few spots. One tool is not pointed, but ends in a small straight unifacial truncation. However, it is not certain that this is not a recent accidental damage.

5. larger artifacts, with a strongly convex base: n = 4
   Four larger triangular and subtriangular bifaces were also recovered, 2 in Clear Fork context, 1 in Round Rock context and 1 from backhoe trench spoil. All four tools have carefully bifacially retouched edges, while base and point are a lot less carefully retouched or not at all in parts.

6. cruder larger artifacts, with a strongly convex base: n = 5
   Five cruder triangular bifaces were found, of which only one could be securely dated in the Twin Sister Phase. One was made on a flake, with careful bifacial retouch on all edges; 2 others had 1 fractured edge from which retouch was resumed. A fourth tool is very irregularly retouched, mostly secondary unifacial on the edges, and not at the base. The last tool is a partially serrated older patinated biface.

B. Medium to large bifaces

1. unnamed biface: n = 1
   A large and very carefully retouched biface was recovered in from Round Rock context. The artifact is very symmetric. This tool is a unique specimen. The regular convex edges meet in a sharp point, the base is slightly concave. All edges are secondary bifacially retouched by small to medium retouch. There are no traces of edge smoothing. On the base are traces of resin, especially on 1 face. The resin is probably of vegetable origin, most probably cedar resin.

2. <u>unnamed biface</u>: n = 1
Another well worked specimen that was recovered from this site, could not be dated. The tool has slightly convex edges and base, all finely retouched by secondary bifacial retouch. There are no traces of grounding on the tool edges. This biface is also a unique specimen.

3. <u>unnamed biface</u>: n = 1
Another tool found in undatable mixed upper levels has a carefully worked basically triangular biface with 1 straight and 1 slightly concave edge. The base is round. The tool is pointed but not very sharply. There is some light grounding on the base and on the concave edge. This biface is a unique specimen also.

4. <u>irregular subtriangular biface</u>: n = 4
Two triangular and 2 subtriangular bifaces were recovered from the site. The first two were collected from Twin Sisters and San Marcos levels; the two from Round Rock and San Geronimo levels. Two of these tools are rather irregularly retouched. One of the larger tools is almost finished, except for a thick lump on 1 surface which could not be removed. And one of the triangular tools is also intensively bifacially retouched, with extensive bifacial thinning of the base. The 2 other tools are more irregularly retouched and the bifacial retouch is not always completed on all edges.

5. <u>with a strongly convex base</u>: n = 4 (1 burned)
Three triangular bifaces with pronounced convex base were recovered from this site, 2 of them come from mixed upper levels, 1 from Clear Fork context. All three are relatively wide triangles; two are not bifacially retouched on all edges, 1 is an entirely bifacially retouched tool; this last tool is made of a different brown spotted flint.

6. <u>triangular bifaces with a straight oblique base</u>: n = 1
A long and narrow triangular tool was made on a Sb flake, the bulb at a basal corner, removed by large ventral retouch. Characteristic for this tool is its oblique straight base. Another tool with this feature was recovered from site 41WM328. At site 41WM56 the tool was found in backhoe trench material and is undated.

7. <u>irregular elongated subtriangular bifaces</u>: n = 1
From San Geronimo context at this site is a patinated biface with planoconvex cross-section damaged the base. The tip is convex, and not pointed at all.

8. <u>elongated triangular bifaces, medium length</u>: n = 7
Four long triangular bifaces were recovered from very different cultural zones; one from mixed context, one mixed San Marcos, 1 Twin Sisters, and 1 Clear Fork. All are

rather different in length, but none is very carefully retouched, and that on the edges mainly. The points are a little bit rounded. Two artifacts are damaged.

Three other medium large bifaces were found at the site, 2 of which could be dated in the Clear Fork Phase. One is especially remarkable because of the fine, regular serration on both edges, starting a little above base and continuing to the very tip. The 2 other bifaces are a little less well worked but still very carefully. One has convex edges, at one point wider than the base.

9. very elongated triangular biface: n = 1
Resembling the above artifacts is a very regularly bifacially retouched, elongated, and narrow triangular biface, found in mixed levels at this site. A similar, but equally undatable biface, was recovered from site 41WM258.

10. 'teardrop' bifaces ('biface en larme'): n = 3
Three bifaces in 'teardrop' form were recovered from this site, two of which are dated in the Clear Fork level. One tool was made on a flake and is retouched almost completely covering. The tool is very sharply pointed. A second tool has a partially unfinished base, but the rest of the tool is as carefully retouched as the other tools.

11. wide subtriangular bifaces with convex edges: n = 1
One biface dated in the Clear Fork level and found in mixed San Marcos context have convex nearly parallel edge over 3/4 of their length and then taper to a point. For both tools the edges are carefully secondary bifacially retouched, and the base is only a little bit worked. Both tools are pointed, although one still has a small amount of cortex on the tip.

12. triangular subtriangular bifaces with a convex base: n = 3
Two undatable bifaces and one biface of San Geronimo context were discovered at this site. All are pointed, and have strongly convex bases. One of the bifaces has this convex base secondarily unifacially retouch so that this tool end looks similar to a scraper.

C. Bifaces with an accentuated, pointed working end

1. finished tools: n = 4 (1 burned)
Four bifacially worked tools, with emphasis on a long and sharp working were found. Two were in distinct Clear Fork context, one in possible Round Rock or Clear Fork;the fourth one is patinated and was found in a mixed Austin level.

The first three tools are basically triangular shaped, but at about 2/3 of their length, there is a slight narrowing

on both edges, towards a sharply pointed tip. The fourth tool is similar, but here the bifaces edges are roughly parallel for about 3/4 of their length. The very tip of the tool is reworked.

D. Stemmed, notched and shouldered bifaces

1. unnamed biface: n = 1
A unique biface, with a stem formed by mild strangulation, was found in the San Geronimo cultural level of this site. The cross-section of the tool is planoconvex due to the fact that the tool was made on a flake or blade; large parts of the ventral face are still visible on the flat face of the tool. The biface is pointed, although the point is not sharpened.

2. unnamed biface: n = 1
A unique tool that reminds very much of a sickle was unfortunately recovered from mixed cultural levels, and cannot be accurately dated. The tool was made on a cortex flake and is considerably patinated. The tool was most probably made on a flake, but of which the original shape and orientation could not be reconstructed.

Most retouch is dorsal, except for some intensive flat to oblique ventral retouch midway the strongly convex left edge. The rest of this edge has oblique large or very large retouch, less regular in the middle part; a shallow notch, very carefully retouched, forms a handle. The right edge is deeply concave and very steeply retouched on the dorsal face by large retouch. Both extremities are rounded and only very sparingly retouched.

3. cornertang-knife: n = 1
The only 'cornertang-knife' recovered from both reservoirs came from this site, but in the same mixed level as the sickel mentioned above. The tool has been carefully bifacially retouched, entirely covering on both faces. The basic shape is triangular, with both edges slightly curved, 1 slightly convex, the slightly concave, the latter also containing 1 notch for the 'corner-tang'; the second notch is in the base. Both notches are made by 2 large bifacial flakescars, and some smaller retouch towards the corners. The tool is sharply pointed, accentuated by a slight tapering of the concave edge.

4. unnamed biface: n = 1
Another biface recovered from this site is a basically triangular, pointed bifaces with slightly assymmetric edges, whereof the base has two small notches, forming small wings on the corners. The reason why this tool has not been included in the projectile point category is the large dispro-

portion of an almostnonexisting stem to a large slightly assymmetric body even if the short wings and notches resemble some projectile point features.

5. notched bifaces: n = 2
Also recovered from this site were two bifaces with a single notch in a convex base. For each biface the notch was made by multiple bifacial retouch and in both bifaces the notch was 1/3 of the total base length from a basal corner. This puts the notch too close to the length axis of the biface to be considered as an unfinished projectile point or projectile point preform.

One tool was recovered from backhoe trench spoil, the other one comes from the Round Rock levels. The latter tool is a carefully bifacially retouched tool, pointed, but not very sharply; the other biface is equally carefully retouched at the base only, while the rest of the tool, especially the point, is rather crudely retouched.

E. Preforms

1. intensively worked preforms
   a. small suboval or subcircular bifaces: n = 7
   All these artifacts are more or less regularly bifacially worked around the edges, and are relatively thin. Most are suboval in outline. It is also possible some of these artifacts are recently damaged.

   b. medium sized suboval or subcircular bifaces: n = 2
   As above artifacts, but larger and relatively thicker.

   c. preforms, pointed at one extremity: n = 9
   Irregular bifacially worked artifacts retouched over all edges. Nearly all tools are distinctively pointed, some sharply. Most artifacts retain some cortex or other anterior surface, i.e., a ventral face (4), cortex (2), or both (1). One of the artifacts was made in a coarse flint.

   d. medium sized preforms, without a pointed extremity: n = 3
   Two artifacts were irregularly bifacially retouched on all their edges. The third tool was not retouched on the base which is steep and cortex covered. All these artifacts are very irregular in outline.

   e. large and elongated preforms: n = 2
   One tool is retouched entirely by relatively few large retouch, covering the entire artifact. The other tool is a little more regular and is pointed at one extremity; it has some anterior patinated surface along most of one edge.

f. miscellaneous: n = 2
Apparently both artifacts are nearly completed bifaces, but they can not be integrated with any of the other types.

One tool is a more or less pointed biface with a rounded base, the pointed end of the tool accentuated by a distinct narrowing of the edges. Maybe this tool is an unfinished artifact.

The other tool is a large ovoid tool, made on a very large Sb flake, with 2 convex extremities slightly tapering towards to the top. It is possibly an unfinished type.

2. less intensively worked preforms

a. medium sized and large elongated preforms, one extremity slightly pointed: n = 6
The artifacts are very irregularly retouched and do retain important amounts of cortex (4) or older patinated surface (1). The retouch is mostly secondary unifacial. sometimes bifacial, and envelop only part of the edge(s).

b. rectangular preforms: n = 1
This one artiface is retouched bifacially along 1 edge, unifacially from a steep cortex back on the other edge. Also one extremity is retouch from a steep cortex platform; the other extremity was unretouched. It is possible that this tool is a modified core.

c. large ovoid preforms: n = 13
The artifacts were made by irregular centripedal retouch, with amounts of cortex remaining on 5 tools. The retouch is usually bifacial, but sometimes unifacial also. Few of the artifacts are slightly pointed at one extremity.

3. preforms with minimal retouch

a. miscellaneous: n = 6
1. This site is the only one in both reservoirs where these artifacts were recovered. All are exceptional, assymmetrical tools, usually only very rudimentary flaked. The one exception is an ovoid tool, possibly derived from a core, battered at 1 extremity, although it is not clear what the tool was used for, because the battering is atypical, i.e., not as seen on hammerstones or as on some scaled/battered pieces.

F. Biface fragments

1. basal fragments

a. basal fragments with a more or less straight base, the edges at right angles with the base: n = 20 (2 burned) The two smallest fragments are possibly point fragments, the others are biface fragments. Most fragments have a slightly convex base; only 1 has a straight base. One fragment is exceptional because of its very large length and parallel edges: at the fracture point, there is still no indication of tapering towards a point. Two fragments retain a trace of cortex, and two are made on flakes, the ventral face still partially visible. One tool is a partially reworked older patinated bifacial tool.

b. basal fragments with a more or less straight base, the edges at sharp angles with the base: n = 10 (3 burned) Eight tools are carefully retouched tools fragments, 2 are more roughly retouched. Two other fragments are nearly complete bifaces but an important corner part of the base is missing. Both are triangular medium-sized bifaces. Two fragments are burned, so is one of the preform fragments. Two tools were made on flakes.

c. basal fragments with a more or less straight base, edges at obtuse angles to the base: n = 46 (4 burned) Eleven are roughly bifacially worked fragments, the majority of them are large, and 2 are severely burned. Two of these were made on flakes, secondary b flakes. Most of these tools are rather intensively retouched with large bifacial flaking. Where the retouch is small, it is also scaled. These fragments are relatively thick.

There are 35 finely bifacially-worked fragments, 2 of which are burned. Five fragments still show traces of the ventral face of a flake. One of these fragments was made on an older, slightly patinated flakes and also has a planoconvex cross-section. Five other fragments still retained some cortex; one small fragment has a complete cortex base, bifacial retouch only on its edges.

Five fragments are relatively long ones with parallel or nearly parallel edges. One of them is very narrow.

d. basal fragments with a more or less straight base, the edges at mixed angles to the base: n = 4 One fragment has an almost rounded convex base instead of an angle. One edge is unifacially retouched from a fracture plane. Another fragment is possibly also a

burin spall fragment and is made from a grey-brown semi-translucent flint, mottled with black.

e. basal fragments and convex base: n = 103 (17 burned)
Twenty fragments retained some amount of cortex. Most fragments are moderately well bifacially retouched on edges and mostly on the base as well. Eleven tools were roughly retouched. Seven fragments bore witness to the fact that they were made on an older patinated flake; none was observed to be a reworked older bifacial tool.

Two tools are special. One fragment, rather thick in cross-section, could be the base and beginning of a drill. The other tool is well worked fragment, with half of a notch still preserved on the base corner; the other half is missing, thus closely resembling two other bifaces recovered from this site (see bifaces type D5

f. base fragments with concave base: n = 5
One of five such fragments was made on an older patinated flake.

All 5 fragments are different: one is relatively wide, the other narrow; one has a unifacially secondary retouched basal notch, only partially preserved. The fourth fragment is very narrow (5 mm) with a small secondary unifacially retouched notch. The notch is not accidental or recent, but the fragment could as well be a tip fragment. The fifth could be a projectile point base fragment.

g. pointed basal fragments: n = 15
All fragments are medium-to-large size; one made on flake. Several (7) fragments still have some cortex, and often the base itself is only crudely retouched.

h. shouldered and tanged basal fragments: n = 5 (1 burned)
Two of the 4 tanged fragments are of the same type as a tanged complete biface recovered from site 41WM267 (cfr. Cervenka). One has a proportionally very small stem compared to the very large body. Both are very carefully bifacially retouched tool fragments. The two other tanged fragments are damaged, and the stem was made by bifacial retouch in 1 fragment, secondary unifical retouch for the other.

The only shouldered fragment was very finely bifacially retouched, vaguely serrated on the edges. The shoulder is damaged on 1 edge, unifacially retouched form a fracture plane on the other edge.

i. special basal fragments: n = 2
One fragment has a more or less rectangular base, and its edges taper sharply from the basecorners in; they are slightly concave.

The other fragment is triangular, made on an older patinated flake. The tip is missing.

j. unfinished basal fragments: n = 46 (4 burned)
The majority of fragments (33) still have cortex on at least 1 face or edge. Four fragments have cortex only at the base. Four were made on flakes, 2 on older patinated flakes.

2. <u>top fragments</u>
a. fragments where the point forms an angle of 90^o
1. small fragments: n = 12 (2 burned)

2. large fragments: n = 24 (6 burned)
Three fragments are large, crudely retouched pieces, with large retouch, and are possibly fragments of unfinished tools. One was made on an older patinated flake, 2 others retain some cortex.

b. fragments with an angle less than 90^o
1. small fragments: n = 70 (24 burned)

2. large fragments: n = 180 (37 burned)
These fragments form a very varied group; there is a large variation in size, as well as in retouch. Most pieces are well retouched, and are most probably broken completed tools, but other flakes are worked only by very large and crude retouch.

Only 2 fragments show a noticeable beveling on 1 edge. There is also a fairly large group of extremely well worked and sharply pointed fragments, several of which have this point extra-accentuated and elongated.

A few pieces show very faint and irregular serration. Eight were made on flakes.

c. fragments where the top forms an angle of more than 90^o
1. small fragments: n = 2

2. large fragments: n = 20 (9 burned)
The majority of the fragments are basal corners of bifaces, but some are wide top fragments.

3. <u>medial fragments</u>
a. narrow medial fragments, width less than 20 mm: n = 30 (12 burned)

The serrated fragment was flaked by fine secondary bifacial retouch.
No fragments testified they were made on flakes. The 2 relatively long and narrow fragments are both partially burned, the wider one at the base, the other one at the tip.

b. medium fragments, width more than or equal to 20 mm and equal or less than 40 mm: n = 89 (31 burned)
Very few pieces, only 4, still have some cortex. Almost all fragments are from finished bifacial artifacts. Only one, maybe two, are from unfinished preforms. One fragment is made of a clear translucent quartz, its cleavage planes are visible. One fragment is patinated, and beveled unifacially on 1 edge by medium oblique retouch.

c. large fragments, the maximum width more than 40 mm: n = 17 (2 burned)
Three fragments are made on flakes, one on deeply patinated flake. Three fragments still have some cortex. Several fragments are roughly bifacially retouched pieces.

4. <u>edge fragments</u>: n = 252 (96 burned)
Two were made on flakes, 1 on an older patinated flake. Thirteen still had some cortex. Most fragments were part of finished bifaces; there are only a few unfinished fragments.

5. <u>unidentifiable fragments</u>: n = 20 (11 burned)

XIII. Axes

A. Axes with a curved bit: n = 2 (whole)

Two axes recovered from this site have a bit distinctly curved. One tool, recovered from backhoe trench spoil and undated, is a completely bifacially worked tool, basically triangular in shape, but with rounded corners. The bit is bifacially retouched by small to medium oblique/flat retouch. The second tool is roughly rectangular in shape, slightly tapering towards the bit, the narrowest edge of the tool. In this tool, the bit is made by secondary unifacial large flat retouch. The rest of the tool is in places carefully retouched, has in other places still cortex on the edges.

B. Bifacially worked axes with a straight bit: n = 6 (whole)

Six bifacially worked axes with a straight bitprofile were recovered from this site. Three axes have an elongated triangular shape, with a blunted tip and straight to light convex bits. All are carefully retouched on all edges with extra retouch of the axe bit. One other axe shape also has a basic triangular type, but only butt and bit are retouched,

both bifacially. This tool was made on a slightly patinated Sb flake. A fifth axe, is rectangular, roughly retouched on all edges, more carefully only on the bit of the tool. The sixth tool is a roughly worked axe, whereof only the axebit is more intensively worked by facial oblique retouch.

C. More crudely bifacially worked axes: n = 4 (whole)

There are four more crudely bifacially retouched axes. Three are irregularly shaped, 1 is elongated rectangular, the later one made on an older deeply patinated artifact. The three irregular axes still have cortex on the butt.

D. 'Planes': n = 2 (whole)

Two planes were recovered from this site. These tools are characterized by a very distinct planoconvex cross-section, while the bit is unifacially worked by large oblique retouch. One tool is made on a flake, retouched mainly on the dorsal face, but ventrally by a few large flat retouch on butt and slightly tapering on the upperhalf of the tool, probably for hafting. The other tool is also made on a flake, but on an older, heavily patinated and previously retouched tool. This former tool had only dorsal retouch, as far as can still be seen. Resharpening mainly happened on the bit, and on 1 edge near the butt. The bit is accentuated on the ventral face by some flat medium retouch. Only 1 more 'plane' was recovered, namely at site 41WM57.

XIV. Chopping tools: n = 4 (whole, 1 burned)

All four tools are roughly retouched pieces, elongated in outline. Only the bit is more carefully and intensively retouched. Large to intermediate amounts of cortex remain at one face, or on some edge parts. These tools are the most elaborately worked among the chopping tools observed in both reservoirs, with the smallest amount of cortex.

XI. Scaled and battered pieces: n = 5 (3 whole, 2 burned)

Two secondary a and 4 secondary b flakes, all large and heavy, had at least 1 edge covered with very intensive scaled retouch. In all but one case that retouch was bifacial. One tool had 2 edges covered by this retouch. Always the battered edge has a slightly convex, but very regular outline.

XVI. Unifacials: n = 5 (1 burned)

All 5 tool fragments are flaked completely covering on their dorsal faces, and were retouched by oblique large retouch from both edges and 1 end. Four fragments have also few flat ventral marginal retouch.

Site 41WM57

I. Scrapers

A. Single endscrapers

1. on flakes: n = 2 (whole)
Both single endscrapers on flake are made on the distal end of Sb flakes by steep to oblique dorsal retouch. One specimen is only a fragment; the other one has some recent damage.

2. on retouched flakes: n = 6 (3 whole)
There are six single endscrapers on flakes with some additional retouch. All except one were made on tertiary flakes. The only exception was manufactured on a Sb flake with only very little cortex.

All tools are distal end scrapers, three are complete, three are fragments, but all are made by steep to oblique dorsal retouch. All the additional retouch is marginal, in two cases distinctly denticulated, along the flake edges. Only an occasional ventral retouch was noticed. Variation in size is rather large.

3. on blades, bladelets or microblades: n = 1 (whole)
This unique specimen is a rather crude blade and tool, damaged along one edge. The very steep dorsal retouch forms a scraperbit on the proximal end that is only partly preserved. The steepness of the retouch may suggest that this is a truncation rather than a scraper.

B. Single sidescrapers

1. on flakes: n = 8 (1 whole)
Of the three single sidescrapers on flakes recovered, only one is a complete specimen. Two are made on Sa flakes, one on a Sb flake. All tools have the scraper bit on the right edge. The one complete tool has a long, straight scraper edge continuing partially on the distal right corner with a strong curve, all by dorsal retouch. The piece is naturally backed on the other edge by a steep cortex back.

2. on retouched flakes: n = 1 (whole)
As for the former scraper category, the scraper edge is on the right edge, formed exclusively by oblique medium-sized dorsal retouch. Additional dorsal retouch on the left edge has a rounded denticulated outline, while there is also some retouch on the distal end. The tool was made on a Sa flake.

C. Double scrapers

1. double endscrapers : n = 2 (1 whole)
One complete and one fragmentary double endscraper were found at the site, the former made on a Sa flake, the latter on a tertiary flake. The complete tool has one pronounced large and one smaller scraperbit. The former is prepared and partially resharpened by flat large to very large ventral retouch.

2. double sidescrapers : n = 2 (1 whole)
One complete and one fragment of a double sidescraper were found, the former made on a Sa flake, the latter on a Sb flake. Only relatively small parts of the scraperbits of the fragmentary tool are preserved, and both seem to have been only dorsally retouched. The other tool has rather crushed flat ventral retouch in the middle of each scraper edge, possibly a result of use.

3. single end and single sidescrapers : n = 2
Two fragments were found that have remnants of a side and an endscraper , one of which was manufactured on a Sa blade, the other on a tertiary flake. The first tool form has a shouldered scraperbit on the distal end of the flake.

D. Multiple scrapers: n = 4 (3 whole)

Four multiple scrapers were recovered, only one of which is an incomplete tool. Two were made on Sa flakes, one on a tertiary flake, and one on a biface fragment. All tools had three scraperbits, which all converge with each other. The scraper made on the biface fragment is irregularly oval, the ones on flake are elongated and one is almost a circular scraper, but its proximal end was not retouched. Two tools are exclusively retouched on the dorsal face, the elongated specimen also ventral on one edge. The biface fragment was retouched by alternating secondary unifacial retouch.

E. Other

1. "giant" scrapers: n = 1 (whole)
One very large side scraper with a very irregularly bifacially retouched and crushed scraperbit was manufactured on a large Sb flake. There is some more dorsal and bifacial retouch on the left edge, especially in a large notch.

2. possible scrapers: n = 1 (whole)
A scraper was made on a biface or biface fragment, of which the pointed end was retouched by a unifacial steep medium-to-large retouch. The scraperbit is slightly concave. Maybe this tool is not a scraper, but neither could it be classified in any other category. The original regularly convexedly rounded base of the biface was retained and remained unmodified.

F. Unidentifiable fragments: n = 4

Four scraper fragments were recovered, three of them seem to be the result of normal fractures.

The fourth is a scraperbit renewal flake; the old scraperbit was removed by a blow given just above the scraperbit, and the spall removed a large part of the ventral face of the tool.

II. Denticulates

A. Serrated pieces: n = 4 (3 whole, 1 burned)

Four serrated pieces were recovered from this site; one that was made on a natural Sb flake has one whole edge completely serrated, 2 tertiary flakes and 1 Sb bladelet are only serrated partially on 1 edge.

B. Denticulated pieces

1. <u>on flakes</u>

a. denticulated only: n = 6 (4 whole)
Three Sb and 3 tertiary flakes were denticulated, 3 of which over nearly a whole edge, 2 right and 1 left edge, 1 by ventral and 2 by dorsal retouch. The 2 fragments and a third complete tool are denticulated on their distal extremities, all by dorsal retouch.

b. <u>with additional retouch</u>: n = 2 (whole)
Both tools were made on Sb flakes, one of which is very heavy. It is only denticulated over a small part of one edge, while the rest of the tool, i.e., the right edge and the distal end, were intensively bifacially retouched, scaled in places. The other tool is also partially denticulated by dorsal retouch on 1 edge, the rest of the edge backed by steep small dorsal retouch.

c. with ventral preparation: n = 1 (whole)
A large and very heavy Sb flake was denticulated on its proximal end, and has some more retouch on other edges, too.

2. <u>on blades, bladelets and microblades</u>: n = 1 (whole)
A heavy Sb blade was roughly and irregularly denticulated over the medial part of its right edge by large dorsal retouch.

C. Denticulated fragments: n = 1

III. Notches

A. Single notches on flakes

1. <u>single notch only</u>: n = 6 (4 whole, 2 burned)
   Two tertiary and 2 Sb flakes are notched by dorsal retouch, 3 on the edges, 1 on the distal end. Two more Sb flakes are ventrally notched, both on the left edge.

B. Multiple notches on flakes

1. <u>non-adjacent notches</u>: n = 2 (whole)
   Two tertiary flakes have multiple dorsally retouched notches spread over both edges and the distal end.

2. <u>occasionally adjacent notches</u>: n = 6 (2 whole, 2 burned)
   One tertiary flake fragment has 2 pair of adjacent notches, 1 on the left edge and 1 on the distal end, both ventrally retouched. Another Sb flake has 2 dorsal adjacent notches, with a single ventral notch on the other edge. A tertiary and Sb flake have in addition to their adjacent notches, by dorsal and ventral retouch respectively, additional marginal dorsal retouch on the opposite edge. Another Sb flake is retouched by large flat ventral flaking on the proximal end.

C. Notched blades, bladelets and microblades

1. <u>single notch</u>: n = 3 (2 whole)
   A Sb blade fragment and 2 tertiary blades have a small, and also shallow in the latter two tools, dorsally retouched notch on 1 edge.

2. <u>multiple notches</u>: n = 1 (whole)
   A large tertiary blade has multiple notches spread over both edges, very regularly retouched by oblique small dorsal retouch.

D. Other

1. <u>meganotch</u>: n = 7 (6 whole)
   One tertiary, 3 Sb flakes and 2 blades, and 1 Sa flake fragment all have carefully retouched meganotches, only 1 of which is made by ventral retouch. One flake has the large notch on the distal end, contrary to all other tools with the notch on an edge. A few tools have some additional continuous retouch on the opposite edge.

2. <u>alternatingly retouched notches</u>: n = 2 (1 burned)
   Two tertiary flake fragments have notches in equivalent loci, on each edge, close to the proximal entremity. One notch is retouched dorsally, the other ventrally.

3. <u>strangulated pieces</u>: n = 1 (whole)
   A Sb blade is slight strangulated near its middle by 2 shallow dorsally retouched notches. They are flaked by small but regular retouch.

E. Fragments: n = 3

The three fragments are all tertiary, with parts of dorsally retouched notches.

IV. "Boring" tools

A. Borers

1. <u>on axis</u>: n = 1 (whole)
The only borer from this site is more on the distal end of a tertiary bladelet. The tool is made by oblique ventral retouch on the right edge, dorsal on the left, continuing on both edges to about the middle of the edges.

B. Drills

1. <u>on point base</u>: n = 2 (1 whole, 1 burned)
Five drills and drill fragments were found at this site, all from the San Marcos/Round Rock transition levels. One complete tool was made on a point base with long wings, another one on a shouldered point base. The latter tool represented only part of the drillbit, which is fire damaged. This last point is not very finely worked.

2. <u>on a retouched base</u>: n = 1
Another almost complete drill has a small basically triangular base, almost perfectly aligned with the drillbit. The sides of the base are bifacially retouched as were the drillbit sides. The base is secondarily unifacially worked by oblique retouch and may be a chisel.

3. <u>fragments</u>: n = 2 (1 burned)
The 2 other tools are fragments. One is a drill tip; the other one is a base and the beginning drillbit fragment, possibly on a point base, but badly damaged by fire.

V. Truncations

A. Single distal truncations

1. <u>dorsal retouch</u>: n = 5 (3 whole)
All tools are made on tertiary flakes, one in a coarser flint with quartz inclusions. Three truncations have no additional retouch.

One fragmentary tool has 2 non-adjacent notches in the truncation, both by oblique to steep dorsal retouch.

One other tool has intensively retouched edges with a thorn-like projection that could possibly be interpreted as a borer. The other edge is also retouched. The truncation of this tool is slightly concave.

2. ventral retouch: n = 1 (whole)
   This tool also has a steep prepared facetted platform, morphologically close to a truncation, giving the tool the appearance of a double truncation.

B. Single proximal truncation

1. dorsal retouch: n = 1
   This truncated tertiary flake has additional, somewhat irregular dorsal retouch on both edges.

C. Unidentifiable fragments: n = 1

The fragment is from a dorsal distal truncation on a tertiary flake, fractured on 2 other sides.

VI. Backed pieces

A. One whole is backed

1. a straight or slightly convex edge
   a. dorsal retouch: n = 2
      Both fragments were made on the right edge of Sb flakes by perpendicular retouch.

   b. ventral retouch: n = 1
      A small tertiary flake fragment was backed along the right edge by oblique to steep ventral retouch.

2. concave edge
   a. dorsal retouch: n = 1 (whole)
      The right edge of this small tertiary flake was very steeply backed, a small fragment on the distal end of the backed edge is missing. The concavity is very shallow.

B. One edge is partially backed

1. dorsal retouch: n = 1 (whole)
   Two thirds of the left edge, i.e., the proximal and medi l parts, of a thin tertiary bladelet were very regularly retouched. The edge outline is slightly convex.

C. Unidentifiable fragments: n = 1

This backed piece fragment is made on a non-cortex fragment that could not be further identified. One edge is backed by very regular medium retouch.

VII. Burins

A. Angle burins

1. single angle burins
   a. on snap: n = 3 (whole)
      All three burins are single angle burins on snap, one made on a tertiary flake, and 2 on point fragments. The last two are multi-facetted, their platform is crushed.

B. Dihedral burins

1. on angle: n = 1 (whole)
   One dihedral angle burin, recovered from San Geronimo levels, was made on a tertiary flake. The flake also has some ventral retouch on themiddle of the right edge.

VIII. Composite tools: n = 1 (whole)

This tool, a scraper-burin composite tool, was made on a teritary flake. There is a small endscraper on part of the distal end, and an atypical dihedral burin on the right flake edge.

IX. Retouched pieces

A. Pieces with unilateral retouch

1. dorsal retouch
   a. retouched edge
      1. *nearly entire edge: n = 39 (16 whole, 4 burned)*

The complete tools are

made on		ret. left edge	right edge
tert. flakes	8	4	4
tert. blades	2	2	-
Sb flakes	5	3	2
Sa flakes	1	1	-
		10	6

All pieces were flaked by small oblique retouch. The edge outlines are regular straight to convex, or irregularly shaped, the retouch following the natural flake edge outline.

The fragments are

made on		ret. left edge	right edge
tert flakes	14	9	5
Sb flakes	6	2	4
Sb blades	1	-	1
Sa flakes	2	1	1
		12	11

2. less than half edge: n = 4 (3 whole)
   One secondary and 2 tertiary complete tools were all retouched on their left edge, one proximal, 1 distal, by small oblique to steep retouch.

   One slightly damaged tertiary flake was also retouched proximal on the left edge.

b. retouched ends
1. proximal end: n = 1
   A Sa fragment was retouched by very regular oblique medium to large dorsal retouch, is close to a scraper, but for a very large ventral flake which removed part of the retouched edge.

2. distal end: n = 5 (2 whole, 1 burned)

made on		whole	fragments
tert. flakes	3	1	2
Sb flakes	1	-	1
Sa flakes	1	1	-
		2	3

The whole tertiary flake is a core trimming element. All other tools have a partially retouched distal end.

2. ventral retouch
a. retouched edge
1. nearly entire edge: n = 22 (11 whole, 3 burned)

The complete pieces are

made on		ret. left edge	right edge
tert. flakes	4	3	1
tert. blades	1	-	1
Sb flakes	4	2	2
Sb blades	2	1	1
		6	5

All flakes and blades were continuously retouched by fine or small ventral retouch along part of 1 edge.

The fragments are

made on		ret. left edge	right edge
tert. flakes	10	3	7
Sb flakes	1	1	-
		4	7

2. less than half edge: n = 4 (whole)
   Three tertiary flakes were retouched on the left edge, 2 proximal and 1 distal, and the Sb flake was retouched proximal on the right edge.

b. retouched end
   1. distal end: n = 3 (2 whole, 1 burned)
      Three tertiary flakes, one of which large and heavy, were retouched by small oblique retouch, the fragmentary tool only on part of its distal end.

3. bifacial retouch

   a. retouched edge
      1. less than half edge: n = 1
         A small part of the left edge of a wide large secondary a flake was bifacially flaked with large oblique to flat retouch.

4. alternating retouch: n = 9 (5 whole, 1 burned)
   a. retouched edge
   The complete tools are

made on		ret. left edge	right edge
tert. blade	3	2	1
Sb flakes	2	2	-
		4	1

All flaking was done by fine, careful oblique retouch.

The fragments are

made on		ret. left edge	right edge
tert. flakes	2	1	1
Sb flakes	2	1	1
		2	2

The retouch on the secondary flakes is generally larger and less careful. One of the tertiary flakes is a bifacial thinning flake.

B. Pieces with bilateral retouch

1. dorsal retouch
   a. 2 retouched edges
      1. 2 nearly entire edges: n = 3 (1 whole, 1 burned)
         All these tools were made on tertiary flakes with small to medium slightly irregular retouch for the tertiary fragment.

2. 2 partial edges,equivalent loci: n = 3 (1 whole, 1 burned)
A tertiary whole flake and a Sb fragment both were retouched near their medial part, another tertiary fragment was retouched proximal.

3. 2 partial edges, unequivalent loci: n = 1
A tertiary flake was retouched in small parts of both edges, by small steep dorsal retouch.

b. 1 edge and 1 end retouched

1. both nearly entirely retouched: n = 1 (whole)
A tertiary flake was retouched by small and medium steep retouch on left edge and proximal end, respectively.

2. ventral retouch

a. 2 retouched edges

1. 2 nearly entire edges: n = 3 (2 whole)

The tools were

made on		whole	fragments
tert. flakes	2	1	1
tert. microblade	1	1	-
		2	1

A large tertiary flake was retouched on its ventral face by large irregular retouch, covering almost the whole surface. Both other tools were retouched by small retouch.

b. 1 edge and 1 end

1. both nearly whole: n = 1
A heavy tertiary flake was very intensively retouched on 1 edge and the proximal end. Possibly also the other edge was retouched, but that edge is completely damaged.

2. both partially: n = 1 (whole)
This tool was made on a Sb flake.

3. alternating retouch

a. two edges, 1 retouched alternatly: n = 2 (1 whole)
Both tools were made on tertiary flakes by small oblique retouch.

4. alternate retouch

a. 2 edges

1. 2 nearly entirely retouched edges: n = 10 (1 whole, 2 burned)

The tools are:

made on		whole	fragments
tert. flakes	8	-	8
Sb flakes	1	1	-
Sb blades	1	-	1
		1	9

All were made by regular small steep or oblique marginal retouch.

2. both edges partially retouched, equivalent loci:
   n = 2 (1 whole)
   One tool fragment was made on a tertiary flake; the complete tool on a Sb flake.

3. both edges partially retouched, unequivalent loci:
   n = 1 (burned)
   This one fragment was made on a tertiary flake.

4. crude retouch: n = 1 (whole)
   A large and heavy Sa flake was retouched over the total length of both edges by very large oblique retouch. Both edges are irregular in outline.

5. double alternate: n = 1 (whole)
   A large tertiary blade was carefully retouched by small oblique to steep retouch over the whole length of both edges.

b. 1 edge and 1 end: n = 1 (whole)
   Two tools were made on tertiary flakes, 2 on Sb flakes by small oblique or flat retouch, occasionally by medium retouch.

5. other
   a. mixed bifacial and unifacial retouch: n = 3
   The fragments were

made on		whole	fragments
tert. flakes	1	-	1
Sb flakes	1	-	1
Sa flakes	1	-	1
		-	3

   b. discontinuous retouch
   1. edges: n = 2 (whole)
      These tools were made on 2 large flakes, a Sb and a tertiary one.

C. Multilateral pieces

1. mixed bifacial and unifacial retouch
   a. 2 edges and 1 end
      1. bifacial retouch on the end: n = 1
         The proximal end of this tertiary flake was bifacially retouched, both edges were partially dorsally retouched.

2. discontinuous retouch: n = 3 (2 whole)
   These tools were made on 2 tertiary flakes, 1 fragmentary, and on a small Sb flake.

D. Special retouched pieces

1. pointed flakes and blades: n = 1 (burned)
   The tool was made on a Sa blade fragment and is retouched on both edges to a pointed distal end which also has few flat covering ventral retouch.

2. pieces with triangular sharp cross-section: n = 1 (burned)
   A long tertiary blade fragment has irregular, possibly use retouch along 2 edges, and few flakes were backed from the central rib towards each edge.

3. retouched burin spalls: n = 1 (whole)
   A primary burin spall with intensive retouch present on the former flake edge, was intensively ventrally retouched along the proximal half of the burin spall's left edge.

4. other: n = 1 (whole)
   A Sb flake with a natural deep concave distal end, was retouched partially along this concavity by small oblique ventral retouch. Similar, but dorsal retouch, occurs on most of the right edge.

E. Unidentifiable fragments: n = 55 (2 burned)

These fragments were made on:	tert. flakes	34
	tert. microblades	1
	Sb flakes	14
	Sa flakes	2
	Sa blades	1
	Chunks	3

X. Bifaces

A. Small triangular and subtriangular bifaces

1. with a straight to slightly convex base, thick in cross-section: n = 1

A very irregular small biface, more or less triangular, was recovered from San Geronimo dated levels. Although recently damaged on the base, the tip is well preserved and is intentionally retouched to a narrow almost straight line.

2. with straight slightly convex base, thin cross-section: n = 1
A regular triangular, thin bifacially retouched biface found at this site was dated in San Marcos-Round Rock transition.

3. cruder larger artifacts with a strongly convex base: n = 1
One cruder triangular biface was found in San Marcos-Round Rock transition context. It appears as if originally the tool was larger, but snapped, and from this fracture, new attempts to thinning were made, on 1 face only. Both edges are secondary unifacially retouched.

B. Medium to large bifaces

1. unnamed bifaces: n = 1
A large biface, pointed, and with a strong convex base was excavated in the San Marcos-Round Rock transition context. Most of the tool is retouched by large primary retouch only; very little secondary flaking was done along the edges. Nevertheless the biface is fairly regular in outline.

This tool is comparable to a 'thin ovate biface' in the Round Rock phase by F. Weir (1976, p. 60, Fig. 17B) except for the secondary finish. Another similar tool was found at this site 41 WM 258. but here the tool was very differently in the Toyah levels of the site.

2. unnamed bifaces: n = 2
Two wide triangular bifaces found at the site were both in San Marcos-Round Rock transition context. Both tools are wider than average, and the maximum width is close to the baseline of the tool. One tool has a unretouched base, the other tool is made on a flake.

3. irregular subtriangular bifaces: n = 2
Two large, more or less triangular, bifaces were recovered from San Marcos-Round Rock transition levels. The largest biface is crudely retouched, not completely bifacially retouched on all edges; bifacial thinning on 1 face. The smaller biface has intensive bifacial thinning of the base and bifacially retouched edges and tip. This tool is heavily patinated on 1 face, less on the other. Neither one of the 2 tools is sharply pointed.

4. triangular bifaces: n = 3
Of three large triangular bifaces found at this site, 2 are from San Marcos-Round Rock transition, 1 is from the Clear Fort focus.

All three are rather finely worked, sharply pointed; two have a slightly concave base, the third one has a straight base. Only one is completely symmetrical, the other two are slightly assymmetrical.

5. elongated triangular bifaces, medium length: n = 1
   This long triangular biface, very similar to one found at site 41 WM 56 was recovered in the San Marcos-Round Rock transition.

6. unnamed bifaces: n = 1
   From a San Marcos-Round Rock transition context came a very finely retouched biface, made on a flake. The dorsal face has almost completely covering retouch, and a large part of the ventral face is still visible. Both the edges and the tip are very completely retouched; a little less care was expended on the base. The edges are parallel up to 3/4 of their length and then angle to a sharp point. Two similar tools were recovered at site 41 WM 264, one of them in a San Marcos context (cfr. p. 267/).

7. irregular subtriangular bifaces with a convex base: n = 1
   From San Marcos-Round Rock transition at this site came an assymmetric biface, bifacially secondarily retouched. The base is convex; the tip is pointed sharply, bent slightly out of the tools length axis.

C. Stemmed-shouldered-notched bifaces

1. unnamed stemmed bifaces: n = 1
   One biface with a faintly stemmed base came from the San Geronimo levels from this site. One edge of the tool is still unworked, while the distal end snapped, but retouch was attempted from the fracture. The basal part of the tool is comparable with 2 bifaces found at site 41 WM 267 (cfr. 264, p.).

2. unnamed shouldered bifaces: n = 1
   From the San Marcos-Round Rock transition levels at this site an assymmetrical biface was recovered, very similar to another undated biface found at site 41 WM 267 (cfr. 267/ p). Although this tool is larger and less intensively retouched, it was also made on an older patinated bifacially retouched tool. The distal part of this biface is rounded instead of pointed.

D. Miscellaneous

1. unnamed biface: n = 1
   A large, entirely bifacially retouched tool, with a distinct planoconvex cross-section was found in San Geronimo dated levels of the site. One extremity of the tool has been damaged. The flat face is covered by large flat retouch, the

upper face is steeply to obliquely retouched by large retouch, more careful on the preserved extremity. This extremity was probably the working end of the tool, considering its more careful retouch and some crushed retouch on the ventral face, that could be use damage. The middle part of both edges have clearly been ground or smoothed.

2. unnamed biface: n = 1
From San Geronimo dated levels from this site comes an elongated rectangular biface, much like one found at site 41 WM 267, although shorter. The tool is likewise rather irregularly bifacially retouched. Most interesting for this tool is the material in which it was made. It is one of the rare tools made in chalcedony.

E. Preforms

1. intensively worked preforms
   a. small suboval or subcircular bifaces: n = 1
      This tool is irregularly worked by bifacial centripetal retouch along its edge.

   b. medium sized preforms without a pointed extremity: n = 3
      All three are marked by irregular bifacial retouch around all edges. One tool has some crushed retouched along its base.

   c. medium sized elongated preforms without a pointed extremity: n = 1
      This biface is similar to the above, except for the fact that it is more elongated. It's retouch is heavily crushed.

2. less intensively worked preforms
   a. large avoid preforms: n = 1
      The basal part of this biface is very faintly stemmed, so it is possible that this biface was a projectile point preform.

F. Biface fragments

1. basal fragments
   a. basal fragments with a more or less straight base, the edges at right angles with the base: n = 2
      Two such fragments were recovered, both distinguished by their large width. One tool retains a very small amount of cortex.

   b. basal fragments with a more or less straight base, the edges at sharp angles to the base: n = 2
      Two small such fragments were found at the site, both probably projectile point stem fragments.

c. basal fragments with a more or less straight base, the edges at obtuse angles to the base: n = 5
Five fragments were recovered, one of them small. The two largest ones still have a little cortex, and one is highly patinated.

d. basal fragments with a more or less straight base, the edges at angles from the base: n = 1
One fragment was found, its base unifacially retouched after lateral primary preparation.

e. basal fragments with a convex base: n = 17 (1 burned)
All fragments are medium to large. The large fragments are all less carefully retouched with large and irregular bifacial retouch, often partially unifacial.

One large fragment is exceptional in the way that both edges are not retouched (both are still cortex surfaces) while the base is bifacially retouched, with large lamellar thinning scars on one face. Six fragments were made on flakes.

f. basal fragments with a concave outline: n = 1
A small fragment with a deep basal notch was recovered from this site. The notch was made by a single retouch on a carefully bifacially retouched edge.

g. tapering basal fragments: n = 5
One fragment has both edges covered by cortex, only the base is bifacially retouched, was made on a flake.

One fragment is distinctly assymetric, with one straight and one convex edge, coming together in a sharp point. The whole convex edge and the basal point of the right edges are oblique secondary unifacially retouched.

h. special basal fragments: n = 3
Two roughly and 1 carefully retouched fragments could not be classified elsewhere. The two former were made on flakes and are unfinished tools. The third had apparently a strong convex base and tapering edges, but the orientation of the fragment is very uncertain.

i. unfinished basal fragments: n = 5
There are three crudely and 2 more carefully bifacially retouched fragments, 4 with cortex.

2. <u>top fragments</u>
   a. fragments where the point forms an angle equal to 90^{0}
      1. small fragments: n = 3

2. large fragments: n = 3 (1 burned)
   One fragment retained a little cortex.

b. biface fragments where the top forms an angle less than 90^{0}
   1. small fragments: n = 9 (1 burned)
      One fragment may possibly be the tip of a drill bit, but the fragment is too small to say so with certainty.

   2. large fragments: n = 34 (6 burned)
      Five out of 34 fragments preserved part of a previous ventral surface, one was made on a cortex flake. An equal number of flakes was carefully retouched and sharply pointed, as the 41 WM 56 artifacts, although none has the accentuated point. One fragment could be an extremely long projectile point wing. No bevelling was noticed.

c. biface fragments where the top forms an angle greater than 90^{0}
   1. large fragments: n = 7 (1 burned)

3. <u>medial fragments</u>
   a. narrow fragments, the maximum width less than 20 mm: n = 7
      One fragment is partially patinated.

   b. medium fragments, the maximum width more than or equal to 20 mm and less than or equal to 40 mm: n = 12 (3 burned)
      One biface fragment was made on a flake.

   c. large fragments, the maximum width more than 40 mm: n = 5 (1 burned)
      One fragment was made on a flake. The fragment has a natural perforation, lined with cortex, very close to the narrowest bifacially retouched edge.

4. <u>edge fragments</u>: n = 33 (11 burned)
   Two fragments were made on flakes; one still has part of the bulb and platform. One fragment is serrated.

5. <u>unidentifiable fragments</u>: n = 2 (1 quartz)
   It is uncertain whether the quartz fragment is retouched or not.

XIII. Axes

A. <u>'planes'</u>: n = 1 (whole)
   The plane recovered from this site comes from the San Marcos-Round Rock transition period. The tool was made on a heavy triangular flake, no cortex, and is slightly crushed on the prominent dorsal rib, as well as on both edges, near the tool bit towards the middle of the tool. The tool bit is retouched by large oblique dorsal retouch and damaged by 1 large ventral flake.

Site 41WM73

I. Scrapers

A. Single endscrapers

1. single endscrapers on retouched flake: n = 1
This tool is a single endscraper made on a retouched Sb flake, with a strongly convex scraperbit quite well made by dorsal retouch. The rest of the tool is rather unusual. The major part of the proximal half was bifacially retouched on both edges by completely covering retouch.

2. transverse scrapers: n = 1 (whole)
This transverse scraper was manufactured on a Sb flake by flat, very large, ventral retouch and steep large dorsal retouch.

B. Single sidescrapers

1. single sidescrapers on retouched flakes: n = 4 (2 whole)
This category is the one best represented at this site. All are made on cortex flakes, two on Sb and two on Sa flakes. One tool is rather large and could fit in the "giant" scraper category. Three tools are almost straight including the large specimen, and three tools have their scraperbits on the left edge, one on the right, all of which are dorsally retouched. The additional retouch on all tools consists of notches, one denticulated, obtained mainly by dorsal retouch.

2. inverse sidescrapers: n = 1
A fragment of intensively retouched inverse scraper made on a tertiary flake edge.

C. Double scrapers

1. single end-and single sidescrapers: n = 2 (1 whole)
One fragmentary and one complete single end- and single side-scraper were recovered from this site, both made on tertiary flakes. The complete specimen has two nearly straight scraper-bits, one on the distal end, one on the left edge, and some additional retouch on the right edge. All retouch is oblique dorsal retouch, small on the distal end, gradually changing to very large on the left edge.

2. double sidescrapers: n = 3 (2 whole)
Two complete and one very fragmentary double sidescraper come from this site, two made on Sb flake, one on a primary flake. Both complete specimens are made on larger than average flakes. Retouch is dorsal only for all tools.

D. Other

1. <u>core scrapers</u>: n = 1 (whole)
   One platform of a battered, double platform core was very carefully retouched into a scraper edge. The core retained approximately 20% cortex.

E. Fragments: n = 1

One fragment of a scraper manufactured on a Sb flake by regular dorsal retouch is the only scraper found in the San Marcos levels of the site.

II. Denticulates

A. Serrated pieces: n = 1 (whole)

A tertiary flake was serrated a little irregularly, mainly by fine dorsal retouch in a strongly convex curve over part of the left edge and distal end.

B. Denticualted pieces

1. <u>denticulated flakes</u>
   a. denticulated only: n = 6
      Four of these fragments of tertiary flakes are denticulated on both edges; in two cases by dorsal retouch, the other two by alternate retouch. Both other fragments are denticulated by ventral retouch.

   b. with additional retouch: n = 2 (whole)
      Both tools were made by dorsal retouch on tertiary flakes; one with denticulation on the left edge, the other on the distal end. The latter has both edges obliquely backed by small dorsal retouch. The other tool has the three non-denticulated edges intensively retouched, mainly by flat ventral retouch, scaled in places.

   c. with ventral preparation: n = 1 (whole)
      A heavy Sb flake, was denticulated on all edges with discontinuous, very irregular large flat ventral retouch completely covering the ventral face.

III. Notches

A. Single notches on flakes

1. <u>single notch only</u>: n = 5 (2 whole, 1 burned)
   All tools were made on tertiary flakes; four by dorsal retouch, one by fine ventral retouch. All notches except the latter one,

which is located on the distal end, are on the flake edges. All notches are small and not deep.

2. with additional continuous retouch: n = 5 (2 whole)
Three tertiary and one Sa flake were notched dorsally, one tertiary flake ventrally. The heavy Sa flake is retouched ventrally by nearly covering, flat large retouch. All other flakes have marginal additional retouch, sometimes alternating.

B. Multiple notches on flakes

1. non-adjacent notches: n = 4 (3, whole, 1 burned)
A heavy Sb flake was retouched by large oblique dorsal retouch before the notches were made by rough ventral retouch.

One tertiary and one Sb flake have two dorsally retouched notches, on one edge and end, respectively. Another Sb flake with several dorsal notches also has continuous oblique ventral retouch along one edge.

2. occasionally adjacent notches: n = 4 (1 burned)
Three tertiary and one Sb flake have two adjacent notches; these by dorsal retouch, one tertiary flake by ventral retouch. The notched Sb flake has extensive dorsal retouch on the distal end.

C. Other

1. meganotch: n = 1 (whole)
A large, fine dorsally retouched notch occurs high on the right edge of a large Sb flake. This flake is slightly damaged in places, and also has some additional dorsal retouch on its other edge and distal end.

2. alternatingly retouched notches: n = 1 (whole)
A tertiary flake has two notches, one on each flake edge near the distal end; one retouched dorsally, the other one ventrally. There is some additional ventral retouch along one edge.

3. strangulated pieces: n = 2 (1 whole, 1 burned)
One secondary b flake and a badly burned tertiary flake fragment are both very slightly strangulated by small dorsally retouched notches, closer to the proximal end. For both tools the notches are very shallow.

D. Fragments: n = 3 (1 burned)

One secondary b flake fragment has two adjacent notches, probably dorsally retouched. Another large fragment is a small bifacially retouched notch. The third fragment is aprt of a carefully, dorsally retouched notch on a tertiary flake.

IV. Boring Tools

A. Gravers

1. gravers on the flake edge: n = 1
One "beaked" graver was manufactured on the right edge of a Sb flake by oblique dorsal retouch. The distal end of this tool was also dorsally truncated by steep perpendicular retouch, and forms with the equally steep retouch on the right edge another steep but squared point.

2. oblique gravers: n = 1 (whole)
The second graver at this site was an oblique, sharply pointed graver on the right distal corner of a tertiary flake, made by fine steep dorsal retouch. The rest of the right edge is continuously retouched with the same fine retouch, and the distal end is irregularly denticulated by oblique dorsal retouch; the notches are not deep.

B. Drills

1. on point base: n = 2 (1 burned)
Both drills found at this site are fragmentary tools, made on winged projectile points. One tool lacks only the drill-bit tip; the other one, lacks all of the drillbit and is damaged by fire on the base.

V. Truncations

A. Single distal truncations

1. dorsal retouch: n = 1 (whole)
The tool was made on a partially patinated Sb bladelet by steep, small retouch.

B. Double truncations: n = 1 (whole)

A small square secondary b flake was very steeply truncated on both ends by steep dorsal retouch; the left edge is steeply naturally cortex-backed.

VI. Backed pieces

A. One whole edge is backed

1. a convex edge
a. dorsal retouch: n = 1 (burned)
The tool fragment is part of a Sb flake backed on the right edge.

B. One edge is partially backed

1. ventral retouch: n = 1
The left edge of this Sa flake was backed steep and regular over most of the flake edge length, but the original edge is still remaining a short distance before a distal snap.

VII. Burins

A. Angle burins

1. single angle burins
a. on snap: n = 2 (whole)
Two single angle burins on snap were recovered from this site; one was made on a tertiary flake, and the other on a point fragment. Both tools are slightly damaged, crushed on the working edge; on one piece this damage is possibly recent. The burin on point fragment was renewed.

B. Dihedral burins

1. on angle: n = 1 (whole, burned)
The only other burin from this site is a dihedral angle burin on a biface fragment. The opposite end of the biface fragment was also snapped.

IX. Retouched pieces

A. Pieces with unilateral retouch

1. dorsal retouch
a. retouched edge
1. nearly entire edge: n = 11 (3 whole, 2 burned)
For the complete flakes, two are tertiary flakes, one with a left, the other with a right retouched edge. The third flake is a Sb flake, retouched on the left edge.

The fragments are:

made on		ret. left edge	right edge	undef.
tert. flakes	3	-	2	1
Sb flakes	2	2	-	-
Sa flakes	3	1	2	-
		3	4	1

One Sa fragment is a natural flake.

2. less than half edge: n = 2 (whole)
Partially retouched on the proximal part of the left edge is this large tertiary flake, made of chalcedony.

b. retouched end
   1. distal end: n = 1 (whole)
      A wide Sb flake was retouched by oblique medium retouch in the middle of the distal end.

2. ventral retouch

   a. retouched edge
      1. nearly entire edge: n = 3
         Three small tertiary fragments are retouched by small oblique retouch; two on the left edge, one on the right edge.

      2. less than half edge: n = 2 (whole)
         A tertiary and a Sb flake were both partially retouched on the proximal part of the right and left edge, respectively.

   b. retouched end
      1. distal end: n = 1 (whole, burned)
         This Sb flake was retouched continuously by fine oblique retouch.

3. bifacial retouch
   a. retouched edge
      1. nearly entire edge: n = 5 (1 whole)
         The left edge of a small Sb blade was irregularly bifacially retouched.

         The fragments are:

made on		ret. left edge	right edge
tert. flakes	2	1	1
Sb flakes	2	1	1
		2	2

   b. retouched end
      1. proximal end: n = 1 (burned)
         The platform and part of the bulb of a tertiary flake were removed by bifacial flaking, with accent on the dorsal retouch.

      2. distal end: n = 1 (burned)
         This fragment was made on a Sb flake by regular oblique to flat retouch.

4. alternating retouch
   a. retouched edge: n = 5 (2 whole, 1 burned)
      A tertiary and a Sb flake were retouched alternatingly on the right and left edge, respectively, by small oblique, regular retouch.

The fragments are:

made on		ret. left edge	right edge
tert. flakes	1	1	-
Sb flakes	1	-	1
Sa flakes	1	1	-
		2	1

Both the tertiary and the Sb tools have normal, small flaking. The large Sa flake was retouched very intensively by large and steep retouch.

5. discontinuing retouch
   a. retouched edge: n = 3 (1 whole, 1 burned)
      A heavy Sb flake, a heavy teritary flake, and a Sb blade were all irregularly retouched on the left edge.

B. Pieces with bilateral retouch

1. dorsal retouch
   a. 2 retouched edges
      1. 2 nearly entire edges: n = 4 (2 whole, 1 burned)
         The tools are

made on		whole	fragment
tert. flakes	2	-	2
Sb flakes	2	2	-
		2	2

Three tools are retouched by fine, small oblique retouch, a small fragment by medium, less regular retouch.

      2. 1 nearly entire edge and 1 partial: n = 2 (1 whole)
         A Sb flake fragment and a tertiary fragment were retouched by small oblique to steep regular retouch.

   b. 1 edge and 1 end retouched
      1. nearly entirely retouched: n = 3 (1 whole)
         Two tertiary tools were retouched by small steep, retouch; a third by medium to large steep retouch.

2. ventral retouch
   a. 2 retouched edges
      1. 2 partial edges, equivalent loci: n = 1
         A small tertiary fragment was retouched at the proximal part of both edges forming a short stem.

   b. 1 edge and 1 end
      1. both nearly entirely retouched: n = 2
         Both flakes, a tertiary and a Sb, were retouched by medium and small oblique retouch on one end and one edge, respectively.

3. <u>bifacial retouch</u>
   a. 2 retouched edges: n = 2 (whole)
      These tools were:

made on		whole	fragments
tert. flakes	1	1	-
Sb flakes	1	1	-
		2	-

A large tertiary flake was very intensively retouched, scaled in places; a Sb flake has some ventral retouch.

4. <u>alternating retouch</u>
   a. 2 edges, 1 retouched alternating: n = 4 (3 whole, 1 burned)
      The tools were

made on		whole	fragments
tert. flakes	1	-	1
tert. blades	1	1	-
Sb blades	2	2	-
		3	1

All tools were made by small oblique retouch.

5. <u>alternate retouch</u>
   a. 2 edges
      1. 2 nearly entirely retouched edges: n = 12 (1 whole, 1 burned)
         These tools were

made on		whole	fragments
tert. flake	9	1	8
Sb flake	3	-	3
		1	11

All tools were flaked by small oblique retouch.

      2. 1 edge partially, 1 entirely retouched: n = 1 (whole)
         This tool was made on a tertiary flake by oblique to steep small retouch, partially on the right edge.

      3. both edges retouched partially, equivalent loci: n = 6 (2 whole)
         The tools are:

made on		whole	fragments
tert. flakes	4	1	3
Sb flakes	2	1	1
		2	4

One complete tool is retouched medially, the other distally, by small oblique retouch.

4. both edges partially retouched, unequivalent loci: n = 4 (1 whole)
The tools are:

made on		whole	fragments
tert. flakes	2	-	2
Sb flakes	2	1	1
		1	3

5. 1 edge and 1 end: n = 5 (1 whole)
The few tool fragments were made on tertiary flakes, a complete tool was made on a Sa flake. The latter tool has a very regular low oblique retouch along most of the right edge, the proximal end was worked by large and flat ventral retouch which removed bulb and platform.

6. other
a. mixed bifacial and unifacial retouch
1. 2 retouched edges: n = 1 (burned)
This tool fragment was made on a Sb flake.

2. 1 edge and 1 end: n = 2 (1 whole)
These tools were made on a tertiary flake fragment and a Sb flake.

C. Multilateral pieces

1. discontinuous retouch: n = 11 (6 whole, 1 burned)
They were:

made on		whole	fragments
tert. flakes	5	2	3
Sb flakes	3	1	2
Sb blades	3	3	-
		6	5

D. Special retouched pieces

1. pointed flakes and blades: n = 1 (whole)
A large Sb flake was pointed on its distal end by a very few small retouch.

E. Unidentifiable fragments: n = 29 (7 burned)

These fragments were made on:

tert. flakes	21
Sb flakes	2
Sa flakes	1
chips	2
chunks	3

X. Bifaces

A. Medium to large bifaces

1. irregular subtriangular bifaces: n = 1
A large and wide triangular biface, made on a Sb flake, found at this site could not be dated. The bulb of the flake is in a basal corner and most of the ventral face of the flake is preserved. The bulb was carefully removed. This tool is considerably wider than the other bifaces in this category.

2. 'teardrop' bifaces ('biface en larme'): n = 1
A finely retouched flake in the form of a teardrop was dated in the Round Rock/Clear Fork transition. This is a sharply pointed, slightly assymmetrical biface, very thin with convex bases and edges.

3. irregular subtriangular bifaces with a convex base: n = 1
Very similar to one found at site 41WM267 is this biface found in the Round Rock/Clear Fork transition. This tool is slightly smaller than the one found at site 41WM267, and of the same size as others found at sites 41WM56 and 41WM57.

B. Miscellaneous bifaces: n = 1

A nearly entirely preserved bifacially retouched tool was recovered from the Round Rock levels of the site. The tool is deeply patinated and the small part missing from one edge is also an old fracture. The biface has a straight base, two convex edges that form obtuse angles with the base, and a rounded point. All edges are bifacially retouched, except part of one edge which was steeply unifacially retouched.

C. Preforms

1. intensively worked preforms
   a. medium-sized preforms without a pointed extremity: n = 1
   This artifact is the only possibly unfinished biface recovered at this site. The distal extremity is unretouched, covered by cortex, and the rest of the tool is retouched bifacially by large irregular retouch. This artifact was found in a Round Rock/Clear Fork transition context.

D. Biface fragments

1. <u>basal fragments</u>

   a. basal fragments with a more or less straight base, the edges at right angles to the base: n = 2 (1 burned)
   Of two such fragments one was burned, a small fragment, possibly a point stem. The other tool is an irregularly retouched fragment on an uncommon dark gray flint.

   b. basal fragments with a more or less straight base, the edges at sharp angles to the base: n = 1
   One such base fragment recovered displays strong bifacial basal thinning.

   c. basal fragments with a more or less straight base, the edges at obtuse angles to the base: n = 2 (1 burned)
   Two fragments, 1 large and 1 small, the latter one burned, were recovered.

   d. basal fragments with a more or less straight base, the edges at different angle to the base: n = 2 (1 burned)
   One fragment, bifacially worked on base and edges, one edge much thinner than the other. The thinner edge is partially burned. The other tool is not very well worked, and the sharp angle is rather a curve than an angle.

   e. basal fragments with convex base: n = 10 (1 burned)
   Most of the fragments are large; the smallest fragment is possibly a projectile point stem fragment. Several (3) fragments are rather crudely retouched and contain some cortex. All three fragments have partial unifacial secondary retouch.

   f. basal fragments with a concave base: n = 1
   A rather irregularly bifacailly retouched fragment has a plano-convex cross-section. Both edges and base are denticulated irregularly, by secondary unifacial retouch.

   g. pointed basal fragments: n = 1
   One such fragment recovered has one bifacially retouched edge; the other one partially unworked.

   h. shouldered and stemmed basal fragments: n = 1
   One large fragment, irregularly bifacially retouched, was made on a Sb flake and has a barely discernable stem.

   i. unfinished basal fragments: n = 7
   All fragments are roughly bifacially retouched and are covered partially with cortex. One fragment was possibly intended as a stemmed biface.

2. top fragments
   a. biface fragments where point forms an angle equal to 90^{o}
      1. large fragment: n = 4 (1 burned)
         The burned fragment is possibly a projectile point fragment.

   b. biface fragments where the point forms an angle less than 90^{o}
      1. small fragments: n = 16 (2 burned)
         These fragments are possible projectile point wing fragments; they are slightly curved.

      2. large fragments: n = 23 (4 burned)
         The partially burned fragment is heat damaged on the basal part. There are two sharply pointed fragments, neither of the accentuated type. No fragments were bevelled.

   c. biface fragments where the top forms an angle greater than 90^{o}
      1. small fragments: n = 2

      2. large fragments: n = 7 (2 burned)
         Two fragments are possibly projectile point fragments.

3. medial fragments
   a. narrow fragments, the maximum width less than 20 mm: n = 7 (3 burned)
      One burned fragment is possibly a projectile point wing fragment.

   b. medium fragments, the maximum width than or equal to 20 mm and less than or equal to 40 mm: n = 16 (4 burned)

4. edge fragments: n = 32 (10 burned)
   One fragment was made on a flake, and another fragment was made on an older deeply white patinated flake. One fragment was made from semi-translucent and very fine pale yellow-brown flint, dotted with black. One severely burned fragment is possibly a point fragment.

5. unidentifiable fragments: n = 8 (5 burned)

XII. Gouges: n = 2 (1 whole, 1 burned)

One tool is intensively bifacially retouched, the other unifacially (mainly dorsal face) with some ventral retouch along both edges.

Although both tools are named gouges, they do not fit the description for the 'Clear Fork' or 'Guadalupe' gouge. Both more definitely triangular in outline. Examination under low magnification showed faint

wear on the bit and along both edges, where these were preserved undamaged.

XIII. Axes

A. Bifacially worked axes with a straight bit: n = 1

One fragment contained the bifacially retouched bit of an axe, and there are traces of efforts to rework the fragment into a new axe. Both edges are steeply, alternately retouched by large retouch, giving the tool an odd twisted cross-section.

B. More crudely bifacially worked axes: n = 1

One roughly, bifacially retouched axe was recovered from the Round Rock levels from the site. Only the axe bit is more carefully retouched, although damaged, presumably by use.

XV. Scaled and battered pieces: n = 1 (burned)

The distal end of an "éclat outrepassé" (or "plunging flake") contains part of a intensively scaled bifacially retouched tool. The preserved fragment has one slightly convex and one slightly concave edge.

XVI. Unifacials: n = 1 (burned)

A secondary a flake was ventrally flaked by nearly totally covering, flat large retouch, from both distal and proximal ends, with some retouch from both edges.

Site 41WM304

I. Scrapers

A. Single sidescrapers : n = 3 (1 whole)

Both fragments were manufactured on Sb flakes; one specimen is finely retouched, oblique to dorsal, and the scraperbit only occupies a small part of the edge. The other fragment is much less well preserved, and was severly damaged by recent plough scars. The scraperbit was made by rather steep dorsal retouch, the outline of which is irregular, due to the recent scarring mentioned above. The other edge of the same tool has some additional oblique ventral retouch, which may be a small scraperbit, but was broken by a snap.

The complete tool is a single sidescraper on a Sb flake, the scraperbit is on the right edge, made by regular dorsal retouch, with some ventral denticulated retouch, proximal on the left edge.

B. Double sidescrapers: n = 1

A heavily patinated double sidescraper, of which the proximal part is lacking, was excavated from early Clear Fork levels of the site. The scraperbits on both edges were formed by steep medium dorsal retouch, covering the larger part of the edges.

C. Other

1. "giant" scrapers: n = 1 (whole)
There is one very large sidescraper made on a Sb flake with very large but regular steep to oblique dorsal retouch with come flat ventral retouch. The larger part of the ventral face, as well as the proximal end on the dorsal face are heavily encrusted with calcium carbonate, so that it is impossible to know if the distal end was not a scraper also.

2. core scrapers: n = 1 (whole)
One scraper was made on medium size double platform core, retouched from one platform by large regular oblique to steep retouch, thus forming a regular convex scraperbit.

D. Fragments: n = 3

One fragment was part of a very regular scraper, steeply retouched. The whole fragment, including the fracture planes, was heavily patinated white. The other fragment is probably a scraper renewal fragment, platform and bulb are clearly preserved (type 2 renewal flake).

II. Denticulates

A. Denticulated pieces

1. <u>on flakes</u>
   a. denticulated only: n = 4 (2 whole)
   One whole tertiary flake and one whole Sb flake are denticulated deeply by large dorsal retouch, both over most of their left edge. One of the fragments is ventrally denticulated, the other fragment is denticulated over both edges, by large dorsal retouch.

   b. with ventral preparation: n = 3 (whole)
   Two very large and heavy Sb flakes were intensively retouched on 1 edge. The other much smaller tool, with little cortex left on its dorsal face is denticulated alternately on both edges with the ventral preparation on only 1 edge. This last tool is a little elongated, and is possibly a biface preform.

III. Notches

A. Single notches on flakes

1. <u>single notch only</u>: n = 3 (2 whole, 2 burned)
   One tool was made on a tertiary flake, the other on Sb flakes, 2 tools were notched by ventral retouch, 3 by dorsal retouch. All notches are located on the flake edges, 2 on the right and 3 on the left edge.

2. <u>large and crude notched tools</u>: n = 1 (whole)
   A very heavy Sb flake is notched by dorsal retouch on the left distal corner, and has steep large additional dorsal retouch on the distal end.

B. Multiple notches on flakes

1. <u>occasionally adjacent notches</u>: n = 1 (burned)
   A tertiary flake fragment has 2 adjacent dorsally retouched notches on the left edge.

C. Other

1. <u>strangulated pieces</u>: n = 3 (2 whole)
   Two tertiary flakes and 1 Sb flake are strangulated, 2 by dorsally retouched notches, 1 by 2 small ventrally retouched notches. One heavy tool has the large notches about in the middle of the flake, the 2 other tools have them near an extremity.

D. Fragments: n = 1 (burned)

The fragment is a tertiary flake with the remains of a dorsally retouched notch.

IV. "Boring" tools

A. Drills: n = 1

One single drill fragment, recovered in a Clear Fork focus level, is the only "boring" tool found at this site. The tool is a completely bifacially and covering retouched tool, with a small, basically triangular base. Part of the drillbit is missing.

V. Truncations

A. Single proximal truncation

1. ventral retouch: n = 1 (whole)
A large secondary b flake was truncated steeply by large ventral retouch, while all other edges of the flake were intensively retouched by mainly dorsal large oblique to steep retouch. In several places the retouch is scaled and has blunted the edge considerably.

B. Fragments: n = 1

This tool fragment is only a very small fragment of a distally truncated partially patinated flake--no cortex preserved--by very steep medium dorsal retouch.

VI. Backed pieces

A. One whole edge is backed

1. dorsal retouch: n = 1 (whole)
A tertiary blade was steeply backed over the whole length of its left edge.

B. One edge is partially backed

1. dorsal retouch: n = 1
A deeply patinated Sa blade fragment - the distal extremity is missing - is backed steeply at the proximal end over a short length, continued also over a short length by flat ventral retouch. The rest of this edge is damaged.

C. Double backed pieces

1. edges are straight or slightly convex: n = 1 (whole)
A slightly patinated tertiary blade was backed on both edges by steep dorsal retouch, medium to large retouch on the left edges, much smaller on the right edge.

2. <u>alternately backed edges</u>: n = 1
   A unique tool fragment recovered at this site is a distal fragment, both edges, backed, one by dorsal and one by ventral retouch, and the preserved extremity is also steeply retouched. The fragment is too small, and also partially covered by calcium carbonate to be able to determine the orientation of the flake with certainty.

VII. Burins

A. Angle burins

1. <u>single angle burins</u>
   a. on snap: n = 3 (whole)
      All three single angle burins on snap were recovered from backhoe trench spoil. Two were made on biface fragments, and one on a point fragment.

   b. on truncation: n = 1 (whole)
      One single multi-facetted angle burin on a concave truncation (or large notch on the distal end) was manufactured on a large primary flake. The term concave truncation is not a completely correct one, because the concavity occupies only part of the distal end, and has been made on a previously snapped distal end.

2. <u>double angle burins</u>: n = 1 (whole)
   One double angle burin was made on each side of the base of a nearly undamaged point.

B. Transversal burins: n = 1 (whole)

One transversal burin was produced on the distal end of a large secondary flake with less than 50% cortex from a small snap on the flake edge. The other edge of the flake is oblique to steeply backed by medium to large regular dorsal retouch.

IX. Retouched pieces

A. Pieces with unilateral retouch

1. <u>dorsal retouch</u>
   a. retouched edge
      1. nearly entire edge: n = 9 (2 whole, 3 burned)
         Both whole pieces are Sb flakes, one retouched along the right edge, the other along the left one, both by medium oblique retouch.

The fragments are

made on		ret. left edge	right edge
tert. flakes	3	3	-
Sb flakes	4	3	1
		6	1

2. less than half edge: n = 4 (1 whole, 1 burned)
   A Sb blade was partially retouched in the middle of its right edge. The tool was recently damaged.

   Three heavy, rather crude, Sb flakes, one partially retouched, all 3 on the left edge by large retouch. These fragments are patinated.

b. retouched end
   1. distal end: n = 3 (2 whole, 1 burned)
      Two Sa flakes were steeply retouched by medium to large retouch. The fragmentary flake was maybe part of a truncation or scraper. A tertiary flake has small retouch on part of its distal end.

2. <u>ventral retouch</u>
   a. retouched edge
      1. nearly entire edge: n = 11 (5 whole)
         The complete tools are

made on		ret. left edge	right edge
tert. flakes	4	3	1
Sb flakes	1	1	-
		4	1

One small tertiary flake is a bifacial trimming flake, the Sb flake is a core trimming element. The retouch varies and is fairly steep in places.

The fragments are

made on		ret. left edge	right edge
tert. flakes	3	3	-
Sb flakes	3	2	1
		5	1

2. less than half edge: n = 2 (1 whole)
   Two tertiary flakes were retouched proximal on the left edge.

b. retouched end
   1. proximal end: n = 1 (whole, burned)
      The platform and part of the bulb from a heavy Sa flake were removed by oblique large retouch.

   2. distal end: n = 2 (1 whole)
      A tertiary flake and a tertiary blade fragment both were retouched by large oblique retouch.

3. <u>bifacial retouch</u>
   a. retouched edge
      nearly entire edge: n = 2 (whole)
      A large Sb blade and a tertiary flake were both bifacially retouched along their left edge, not very regularly in either case.

   b. retouched end
      1. distal end: n = 1
         Part of the distal end of this wide and short Sb flake was irregularly bifacially retouched. The bulb and platform of the flake are missing.

4. <u>alternating retouch</u>
   a. retouched edge: n = 2 (whole)
      Two Sb flakes were both modified along the right edge by fine oblique retouch.

5. <u>discontinuing retouch</u>
   a. retouched edge: n = 1
      A heavy Sb flake fragment was retouched irregularly on the left edge.

B. Pieces with bilateral retouch

1. <u>dorsal retouch</u>
   a. 2 retouched edges
      1. 2 partial edges, unequivalent loci: n = 2 (1 burned)
         Both fragments were made on tertiary flakes by small oblique to steep distal retouch.

2. <u>ventral retouch</u>
   a. 2 nearly entire edges: n = 1
      A tertiary flake fragment was retouched by small oblique retouch.

3. <u>bifacial retouch</u>
   a. 2 retouched edges: n = 2 (1 whole)
      These tools were both made on tertiary flakes, intensively retouched on both edges, one edge of the whole tool is very finely worked.

4. alternate retouch
   a. 2 edges
      1. 2 nearly entirely retouched edges: n = 1
         This tool fragment was made on a Sb flake by small oblique retouch.

      2. both edges partially retouched, equivalent loci: n = 1 (whole)
         The tool is partially damaged by recent retouch, but the tool was probably retouched near the proximal end and near the distal end.

      3. both edges partially retouched, unequivalent loci: n = 1 (whole, burned)
         This damaged tool was made on a Sb flake. Most of the fire damage is on the distal end.

      4. crude retouch: n = 1
         A heavy, deeply patinated tertiary flake was retouched irregularly by medium to large retouch over both edges.

5. other
   a. discontinuous retouch
      1. 2 retouched edges: n = 2 (1 burned)
         Both fragments were made on tertiary flakes.

C. Multilateral retouch

1. discontinuous retouch: n = 1 (whole)
   This tool was made on thin small tertiary flake.

D. Unidentifiable fragments: n = 10 (1 burned)

These fragments were made on:

	tert. flakes	5
	Sb flakes	4
	Sa flakes	1

X. Bifaces

A. *Medium and large bifaces*

1. irregular subtriangular bifaces: n = 2
   One medium and one large triangular and subtriangular, bifaces were recovered from Clear Fork context. The smallest biface was lightly patinated on one entire face, while the other face was not at all patinated. Bifacial retouch has a different patina on each face, but they are simultaneous.

   The large biface is made in a rougher flint material and was retouched bifacially with large retouch. It has a straight base and rounded point.

2. irregular elongated subtriangular biface: n = 1
   Recovered in Round Rock context was an irregularly bifacially tool; only the edges are bifacially worked, the two extremities are not worked.

B. Bifaces with an accentuated pointed working end

1. finished tools: n = 1
A very similar tool came from site 41WM56. As in the latter biface, the 2 edges of the biface run nearly parallel for about three-quarters of the length, before tapering into a point. This tool also shows signs of light patination.

2. tools on unfinished or irregularly worked base: n = 1
Also recovered from a level dated in the Clear Fork phase is the following tool. The sharply pointed working end of this tool is very carefully retouched, mainly bifacially. The opposite end, however, is only partly and roughly bifacially retouched and unworked at the base.

C. Preforms

1. intensively worked preforms
    a. medium sized without a pointed extremity: n = 2
    Two large bifaces are retouched bifacially by large irregular retouch, one artifact is thus retouch on all edges, the other one is only partially retouched and retains a lot of natural surface on the edges.

2. less intensively worked preforms
    a. rectangular preform: n = 1
    Both edges of this artifact are regularly bifacially retouched, while both extremities were partially unifacially retouched from snaps.

3. preforms with minimal retouch
    a. unnamed tool, cortex backed: n = 1
    This is a unique tool, the only one found at all the excavated sites. One extremity is roughly bifacially retouched and 1 edge is unifacially retouched. The other edge and the base are covered with cortex.

D. Biface fragments

1. basal fragments
    a. basal fragments with a more or less straight base, edges straight angles to base: n=2 (1 burned)
    Two small such fragments were recovered from this site, both most likely point stems. One fragment is burned.

    b. basal fragments with a more or less straight base, the edges at sharp angles to the base: n = 1
    One large fragment was found at the site, patinated on 1 surface only. One edge has somewhat scaled retouch on 1 face.

c. basal fragments with a more or less straight base, the edges at obtuse angles to the base: n = 5
Five such fragments are present at this site, all very different in size. The two largest ones are patinated; the smallest one is perhaps a projectile point fragment. The large patinated fragment is a very fine secondary bifacially worked fragment.

d. basal fragments with a convex base: n = 6 (3 burned)
Two fragments were made on flakes. The largest fragment is patinated and so is a narrow base fragment, made on a flake with regular bifacial retouch on both edges and the base. One small fragment has a partial secondary unifacially retouched base. Two fragments are more crudely retouched, one of which has a fair amount of cortex on 1 surface.

e. base fragment with a concave outline: n = 1
An irregularly formed biface fragment has an oblique concave-convex base, secondarily unifacially retouched on the concave part of the base.

f. pointed base fragments: n = 1 (burned)
A large and roughly bifacially retouched fragment was found. At the same height, midway of the preserved edge, both edges are oblique to steep unifacially retouched.

g. special basal fragments: n = 1
This fragment resembles strongly a drill base fragment except that the drill bit is more than twice the width of other drills found in both reservoirs. The base is slightly wider than the 'drillbit'.

h. unfinished basal fragments: n = 8 (1 burned)
All fragments are roughly bifacially retouched, all of them with some cortex.

2. top fragments
   a. fragments where the point forms an angle equal to 90^{o}
      1. small fragments: n = 1 (burned)

      2. large fragments: n = 2 (1 burned)
      The unburned fragment has a deep white patina, although the retouch does still look fresh and unrolled.

   b. biface fragments where the point forms an angle less than 90^{o}
      1. small fragments: n = 2

2. large fragments: n = 26 (4 burned)
   One fragment has a plano-convex cross-section. Two other fragments have a small fragment of a ventral surface left on 1 face.

c. biface fragments where the top forms an angle greater than 90^{o}
   1. large fragments: n = 2 (1 burned)

3. <u>medial fragments</u>
   a. narrow fragments, the maximum width less than 20 mm: n = 3 (burned)

   b. medium fragments, the maximum width is more than or equal to 20 mm and less than or equal to 40 mm: n = 11 (5 burned) One fragment is made on a flake; another one has cortex in the middle of 1 face. A third one is patinated; the serration on this fragment is only very faint and is the result of alternate secondary beveling of both edges by medium-sized regular lamellar flaking.

4. <u>edge fragments</u>: n = 23 (7 burned)
   Three fragments were made on flakes; four still retain some cortex.

5. <u>unidentifiable fragments</u>: n = 1

XII. Gouges: n = 1 (whole)

This tool is patinated, and also covered with $CaCO_3$ (calcium carbonate) on 1 edge and the butt. Microscopic analysis of the tool part not covered by $CaCO_3$ revealed that small parts of the edge near the bit were slightly smoothed, and also along the butt part of the gouge.

Site 1WM328

I. Scrapers

A. Single sidescraper: n = 2

Only 2 fragments, probably remnants of sidescrapers, were found. Both scraperbits are made on the right edge of tertiary flakes by steep/oblique medium-sized to large dorsal retouch.

B. Other

1. "giant" scrapers: n = 2 (whole)
The 2 very large scrapers recovered from this site are both complete specimens, one manufactured on a tertiary flake, the other on a tertiary blade. The former has a slightly concave-convex scraperbit on the distal end, flaked by oblique large dorsal retouch, but on the slightly convex part of the scraperbit only. The concave part is naturally oblique.

The other tool is heavily and not very regularly retouched on both edges, as well as on the distal end (so that this tool could also be classified as a double sidescraper). The retouch is predominantly a crushed dorsal retouch, but there is occasional flat ventral retouch, especially on the left edge.

2. core scraper: n = 1 (whole)
This scraper was made on a single platform core, of which the platform-edge has been carefully retouched on one face so as to form a convex regularly curved scraperbit.

II. Denticulates

A. Denticulated pieces

1. on flakes
a. denticulated only: n = 5 (3 whole, 1 burned)
All five denticulated flakes, two Sb flakes and three tertiary, are denticulated only partially on one edge by steep to oblique dorsal retouch. In two cases this retouch is careful and regular. One large Sb flake was deeply patinated white before the distal part of its right edge was denticulated.

b. with ventral preparation: n = 1 (whole)
A very heavy tertiary flake was denticulated primarily on its wide distal end.

2. on blaaes, bladelets and microblades: n = 1 (whole)
   A heavy tertiary blade was denticulated by steep small dorsal retouch on the distal half of its left edge.

III. Notches

A. Single notches on flakes

1. with additional continuous retouch: n = 2 (1 whole)
   One tertiary flake fragment and one Sb flake have a single, dorsally retouched notch on the right edge and distal end, respectively. Both have additional marginal dorsal retouch on the right edge, very steep and oblique. The Sb flake is slightly damaged.

B. Other

1. meganotch: n = 1 (whole)
   A large Sb flake has a carefully, dorsally retouched large notch on its distal end. The proximal end is bifacially retouched, while there is some dorsal retouch on part of the right edge.

IV. "Boring" tools

A. Gravers: n = 1 (whole)

Only one graver was found at this site, in the Twin Sisters levels. This tool, made on a Sb flake, is a good example of the "beaked" graver type. Except for the steep dorsal retouch for the notches that form the sharp graver point, the flake is unretouched.

V. Truncations

A. Single proximal truncations

1. dorsal retouch: n = 1
   A small tertiary flake fragment was truncated steeply by small dorsal retouch and has also some more dorsal retouch on one edge.

VI. Backed pieces

A. One whole edge is backed

1. straight or slightly convex edge
   a. dorsal retouch: n = 1
      A fragment of a tertiary flake was backed by steep retouch on the right edge, with less regular large bifacial retouch.

b. ventral retouch: n = 1
The left edge of this te‹ .‹ary flake fragment was ventrally backed; the flake was damaged by plow scars.

2. concave edge
a. dorsal retouch: n = 1 (whole)
The left edge of a heavy Sa flake was backed roughly and irregularly. Both the proximal end and the right edge were modified by large lamellar flaking, without forming a burin working edge. The concavity is slightly irregular and not deep.

B. One edge is partially backed

1. dorsal retouch: n = 1 (whole)
The medial and distal parts of the right edge of a Sb bladelet are steeply backed by small retouch. The edge is strongly curved towards the tip.

C. Double backed pieces

1. edges are straight or slightly convex: n = 1 (burned)
A medial fragment with more than 50% cortex on the remaining surface is double backed by oblique to perpendicular dorsal retouch. The left edge is much steeper than the right one, and more intensively retouched, almost scaled. Both ends are fractured.

VII. Burins

A. Angle burins

1. single angle burins
a. on snap: n = 2 (whole)
Two single angle burins on snap were found at this site. One made on a biface fragment was recovered from the surface. The other, made on rather thick tertiary flake, was apparently renewed more than once.

2. double
a. on snap: n = 1 (whole)
The only double angle burin on snap, on one extremity, was made on a biface fragment.

B. Dihedral burins

1. on axis: n = 3 (2 whole, 1 burned)
Three dihedral burins on axis were manufactured on secondary flakes, one with less and two with more than 50% cortex. Two tools are partially multi-facetted, one is single facetted only.

2. "reversed" dihedral burins: n = 1 (whole)
This tool is a so-called "reversed" dihedral burin (for description see site 41WM56). This tool is very well made and a unique specimen.

C. Oblique burins

1. <u>from a backed edge</u>: n = 1 (whole)
This burin, made on a secondary flake with less than 50% cortex, is single facetted, from a steeply retouched back. This retouch is steep and large dorsal retouch that is slightly denticulated and appears only on the distal half of the right edge. The proximal half of both edges is less regularly and alternately retouched; ventral on the left edge, dorsal on the right.

D. Multiple burins: n = 1

This tool had at least two burins, but is badly damaged so its characteristics can not be discerned.

E. Tranversal burins

1. <u>single transversal</u>: n = 2 (whole)
Two single transversal burins were made on flakes, a tertiary flake and a secondary flake with less than 50% cortex both are single facetted. Although for both tools the burin scars and the working edge are completely undamaged, the opposed ends of the flakes are missing, and there is not way to know if this was anterior or not to the manufacture of the burins.

2. <u>double transversal</u>: n = 1 (whole)
One double transversal burin was made on a Sb flake; spalled from both edges on the distal end, multi-facetted from the left edge.

IX. Retouched pieces

A. Pieces with unilateral retouch

1. <u>dorsal retouch</u>
a. retouched edge
1. less than half: n = 1 (whole)
A tertiary flake is partially retouched in the middle of its right edge by regular large retouch. The tool has a deep recent notch.

b. retouched end
1. distal end: n = 1
The distal end of a tertiary flake was retouched by oblique medium retouch straight oblique.

2. <u>ventral retouch</u>
   a. retouched edge
      1. nearly entire edge: n = 4 (1 whole, 1 burned)
         A Sb flake is retouched by medium retouch, with an irregular outline. There are three Sb fragments, (two retouched on the right edge, one on the left) all by flat retouch, varying from medium to very large.

      2. less than half edge: n = 2 (1 whole)

   b. retouched end
      1. proximal end: n = 1 (burned)
         This fragment is from a small tertiary flake with some medium oblique retouch.

3. <u>discontinuing retouch</u>: n = 1 (burned)
   A Sb flake has some irregular retouch along the right edge, possibly use-retouch.

B. Bilateral retouch

1. <u>alternate retouch</u>
   a. two edges
      1. both partially retouched edges, equivalent loci: n = 1 (whole)
         This tool was made on a tertiary flake of a coarse flint, by fine and small retouch, near the medial part of the edge for both edges, but less extensive on the left edge.

      2. both edges partially retouched, unequivalent loci: n = 1 (whole)
         This tool was made on a long Sb blade.

      3. double alternate: n = 1
         The tool was made on a tertiary flake by small to medium oblique retouch, very regular on both edges.

   b. one edge and one end: n = 1 (burned)
      The fragment was made on a heavy Sb flake, by medium to large dorsal retouch on the right edge and oblique to flat ventral retouch on the proximal edge.

2. <u>other</u>
   a. discontinuous retouch
      1. one edge and one end: n = 1
         The tool fragment was made on a Sb flake fragment.

C. Multilateral pieces

1. discontinuous retouch: n = 2 (1 whole, 1 burned)
   Both tools were made on heavy flakes, a tertiary and a Sa.

D. Special retouched pieces

1. retouched burin spalls: n = 1 (whole)
   A large atypical burin spall, with a little cortex left on the platform, was retouched on its ventral face on nearly the whole right edge.

E. Unidentifiable fragments: n = 7 (2 burned)

These fragments were made on:

These fragments were made on:	tert. flakes	5
	chunks	2

X. Bifaces

A. Medium and large bifaces

1. <u>triangular bifaces with a straight oblique base</u>: n = 1
   From the Austin component levels of this site came a large triangular biface with a straight oblique base. One edge is entirely retouched, and is faintly serrated. Part of the other edge and the entire base, are formed by fractures; bifacial retouch starts from the flat fracture planes.

B. Preforms

1. <u>intensively worked preforms</u>
   a. small suboval or subcircular bifaces: n = 1
      This tool is a small suboval biface, thinned at both ends. The tool was damaged by some recent retouch. No cortex is present on the artifact.

   b. medium-sized preforms without a pointed extremity: n = 1
      This artifact was irregularly flaked by rough bifacial retouch on all edges. No cortex was preserved on the tool.

C. Biface fragments

1. <u>basal fragments</u>
   a. basal fragments, with a more or less straight base, edges at obtuse angles to the base: n = 5
      All five fragments in this category are large but carefully worked. All are finely secondary bifacially retouched on base and edges. Two have some cortex and one is partially patinated.

   b. basal fragments, with a more or less straight base, the edges at mixed angles to the base: n = 3

Two are bifacially retouched, the third one is secondarily unifacially retouched on both base and edges, all on the same face.

c. basal fragments with a convex base: n = 1
One small fragment was recovered carefully bifacially retouched on both edges, the base slightly damaged.

d. unfinished basal fragments: n = 2 (burned)
One fragment was made on a flake, the other one has some cortex left on one face.

2. top fragments
a. biface fragments where the top forms an angle of 90°
1. large fragments: n = 1
This large fragment has some unifacial tertiary retouch on the long edge, slightly blunting a previously sharp edge over most of its length.

b. biface fragments where the top forms an angle smaller than 90°
1. small fragments: n = 5 (1 burned)
One fragment is slightly serrated, retouched by very carefull bifacial retouch on both edges.

2. large fragments: n = 5
One fragment is possibly a burin spall.

3. medial fragments
a. narrow fragments, width less than 20 mm: n = 2 (1 burned)
One fragments is possibly an edge part with the base of the wing of a projectile point.

b. medium fragments, width more than or equal to 20 mm and equal or less than 40 mm: n = 3 (1 burned)
One large fragment is possibly a biface base (corner) fragment

4. edge fragments: n = 8
Three fragments still have cortex on one face; one fragment with more than 50% cortex and one piece has partial unifacial retouch.

XIII. Axes

A. Bifacially worked axes with a straight bit: n = 1 (whole)

One small triangular axe was recovered from the Twin Sisters levels at the site. All edges, except the narrow butt, have been bifacially retouched. Some intensive retouch on one face of the axebit could be use retouch.

XV. Scaled and battered pieces: n = 2 (1 whole)

A large secondary a flake and a heavy core fragment both have two scaled edges, both convex to slightly convex. Both tools were recovered within the Twin Sisters component of the site.

Granger Reservoir

Site 41WM124

I. Scrapers

A. Single endscrapers

1. single endscrapers on flake: n = 3 (1 whole)
Two fragments and one nearly complete endscraper on flake were recovered from this site. Two were made on tertiary flakes, and one on a secondary b flake. All scraperbits were made on the distal end of the flakes, by dorsal, oblique to steep, small to medium retouch.

2. single end scrapers on a retouched flake: n = 1 (whole)
This single endscraper was made on a retouched tertiary flake by oblique, medium dorsal retouch on the proximal end of the flake. The marginal retouch on the remainder of the flake is minimal and irregular. This tool is small.

B. Single sidescrapers

1. single sidescraper on flake: n = 3 (2 whole, 2 burned)
Of these three single sidescrapers, two were made on secondary a flakes and one on a primary flake, but all three are rather heavy cortex flakes. All scraperbits were manufactured by steep and oblique, large to very large, dorsal retouch. Only on one tool does the scraperbit take up the whole length of the flake edge; the others cover only part of the flake edge.

2. single sidescrapers on a retouched flake: n = 2 (2 whole, burned)
Two single sidescrapers were made on retouched flakes, one on tertiary flake, and one on a secondary b flake. Both tools were made in a finely banded flint; one burned to different shades of red, the other one in dark and light grey of possibly the same material. It is possible that the first tool had two scraperbits, the second one made on a small plunging part on the distal end. The second tool is a rather atypical, crudely retouched scraper, with flat ventral preparation by large retouch.

C. Double scrapers

1. single end- and single sidescrapers: n = 1 (whole)
One single end- and single sidescraper was made on a tertiary flake by steep, medium dorsal retouch. The scraperbit on the right edge is restricted to the distal half of the flake, and the distal scraperbit is also rather small, but strong convex and slightly denticulated. The left edge is irregular in outline and is retouched by crude irregular bifacial retouch.

D. Other scrapers

1. corescrapers: n = 2 (1 whole)
One corescraper was made on a fragment of a double (or multiple) platform core. The other corescraper is a double scraper; both platforms of an elongated double wedge core were modified into scraperbits.

E. Unidentifiable fragments: n = 3 (2 burned)

One fragment is an unidentified burned scraperbit fragment, the other two fragments are scraperbit renewal spalls. One renewal spall was removed by method #1, but on the ventral face, since this particular fragment came from an inverse scraper. The second fragment was removed by method #2, and is a large flake. (For a description of the different methods, cfr. 41WM56).

II. Denticulates

A. Serrated: n = 1 (burned)

A deeply burned medial fragment of a Sb flake was serrated regularly by dorsal retouch on its distal end.

B. Denticulated flakes

1. <u>denticulation only</u>: n = 2 (1 burned)
A tertiary flake is denticulated partially on the left edge by dorsal retouch; another fragment has large ventral denticulation on the distal end.

2. <u>with ventral preparation</u>: n = 2 (whole)
Both tools have extensive ventral preparation by large and flat retouch; both were made on heavy Sb flakes, one on the proximal end, one on its right edge.

C. Fragments: n = 1

This fragment is a very small non-cortex edge part of a denticulated piece.

III. Notches

A. Single notches on flakes

1. <u>single notch only</u>: n = 15 (10 whole, 3 burned)
All but three tools were made on tertiary flakes; the others are on Sb flakes. At this site most notches are made by dorsal retouch, most of them located on both edges, three on the distal end. One of the ventrally retouched notches is on the proximal end.

2. <u>with additional continuous retouch</u>: n = 2 (whole)
Of two tertiary flakes, one was dorsally and one was ventrally notched with small marginal dorsal and ventral additional retouch, respectively.

B. Multiple notches on flakes

1. non-adjacent notches: n = 1 (burned)
   A secondary b flake fragment has two non-adjacent notches on its left edge; one ventrally retouched, the other one dorsally.

2. occasionally adjacent notches: n = 1 (whole, burned)
   A secondary b flake has two adjacent notches, both entirely bifacially retouched.

C. Other notched pieces

1. strangulated pieces: n = 2 (1 burned)
   Two secondary a flakes are slightly strangulated by dorsally carefully retouched notches, which for the large flake are not entirely parallel.

D. Fragments: n = 5 (1 burned)

Two small tertiary fragments have parts of dorsally retouched notches; two other are tertiary, but ventral and dorsal could not be distinguished any more. A larger secondary a fragment has part of a large bifacially retouched notch.

IV. Boring Tools

A. Gravers

1. gravers on axis: n = 2 (whole)
   One finely retouched and sharply pointed graver is made on the distal end of a small tertiary flake by steep, small steep dorsal retouch. The other tool is a sharply pointed graver, made on the distal end of a small secondary b flake, formed by two small, dorsal, perpendicularly retouched edges; a straight edge from the right, and a deep notch from the left.

2. heavy gravers, with triangular cross-section: n = 3 (1 whole)
   The three other gravers on flake axis have more squarely pointed graverpoints, although still sharp. Two were made on tertiary flakes, and one on a secondary b flake, the latter one of which is retouched on the ventral face. One other tool, made on a tertiary flake, has the graverpoint on the proximal end of the flake, which is rather unusual in this assemblage.

3. gravers on the flake edge: n = 3 (1 whole)
   One of these gravers on flake edge is a 'beaked' graver; it was made on the right medial edge of a tertiary flake. Except for the two wide notches that form the sharp graverpoint, there is no retouch on the tool.

The two other tools appear to be a variation of the previous ones, and were seen only at this site. Two 'beaked' gravers were made by ventrally retouched notches on a previously obliquely and dorsally backed flake edge. One tool was made on a secondary a flake, the other one on a secondary b flake.

B. Borers

1. borers on axis: n = 1 (whole)
   One borer was made on the point of a large projectile point by steep secondary, unifacially alternating retouch. One edge of the point shows a very long burin scar, prior to the manufacture of the borer.

2. oblique borers: n = 1 (whole)
   A second borer is oblique, and was made on a secondary b flake. The natural cross-section of the flake at that particular flake part was already triangular, and was further adapted by retouch.

3. other borers: n = 1 (whole)
   This borer was made on a narrow sliver of a flake, no cortex left on the dorsal face. An already sharp point was modified by little retouch on both edges into a very sharp borer point.

C. Other borer tools

1. pics: n = 1 (whole)
   One very roughly retouched older and very heavily patinated secondary b flake was retouched into a curved 'borer tool'. The retouch is almost exclusively dorsal and very intensive, especially on the concave edge.

V. Truncations

A. Single distal truncations

1. dorsal retouch: n = 3 (1 whole)
   One fragmentary tool was made on a tertiary flake; the other tool was made on a Sb bladelet by fine steep retouch with some flat ventral retouch.

   A third small tool fragment made on a flake with more than 50% cortex was truncated by steep dorsal truncation, continuing on the short length of both flake edges.

B. Single proximal truncations

1. ventral retouch: n = 1 (burned)
   The tool fragment was made on a tertiary flake by steep medium retouch and was the only burned truncation recovered in both reservoirs.

VI. Backed pieces

A. One whole edge is backed

1. <u>straight or slightly convex edge</u>
   a. dorsal retouch: n = 1 (burned)
      The fragment is a small part of left edge backed secondary flake.

2. <u>convex edge</u>
   a. dorsal retouch: n = 1 (whole)
      This backed tool, on the left edge of a Sb flake, was snapped on the proximal edge, but retouched on the dorsal face from the fracture plane. The backed edge is slightly denticulated, and some ventral retouch on the right edge.

3. <u>concave edge</u>
   a. ventral retouch: n = 1
      This small fragment of a tertiary flake is the only one recovered with a concave backed left edge retouched by ventral retouch.

B. Double backed pieces

1. <u>the edges are straight to slightly convex</u>: n = 1 (whole)
   A tertiary bladelet is backed straight, both edges parallel, by steep but small dorsal retouch.

C. Special

1. <u>backed and truncated tools</u>: n = 1 (burned)
   This tool is a very small fragment of a tertiary flake truncated and backed on one edge by oblique to steep dorsal retouch.

D. Fragments: n = 2

One is a fragment of a tertiary flake, backed on the right edge; the other fragment is a thin spall, part of a flake edge. Both were dorsally retouched.

VII. Burins

A. Angle burins

1. <u>single angle burins</u>
   a. on snap: n = 3 (whole)
      Two burins on snap were made on a secondary b flake, another one on a biface fragment. Both were made by two burin scars.

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2. double angle burins: n = 2 (whole)
Both tools are double angle burins, on one extremity only; one was made on a tertiary flake, the other on a biface fragment, both by single burin scars.

In general, the flakes that were used are larger than the biface fragments, while the latter are also more carefully retouched. One of the biface fragments is an unidentifiable fragment, the other is a base fragment.

B. Dihedral burins: n = 1 (whole, burned)

The tool is a single dihedral burin on angle, made on a tertiary flake, and resharpened once.

C. Transversal burins: n = 1 (whole)

This tool is a single transversal burin, made on a tertiary flake. The burin blow was struck from a single facetted prepared surface, but was not retouched.

IX. Retouched Pieces

A. Pieces with unilateral retouch

1. dorsal retouch
a. retouched edge
1. nearly entire edge: n = 9 (2 whole, burned)
Both whole pieces are tertiary flakes, retouched on their right edge.

The fragments are:

made on		ret. left edge	right edge
Sec. b flakes	4	4	-
Sec. b bladelets	1	1	-
Sec. a flakes	2	1	1
		6	1

2. less than half edge: n = 1
One secondary b flake fragment is retouched on its proximal left edge. The flake also has a deep recent notch.

b. retouched end:
1. proximal end: n = 2 (1 whole)
A tertiary flake is retouched by deep dorsal retouch along the platform, oblique to the left edge. A secondary b fragment is retouched obliquely, but part of the proximal end is missing. This tool is possibly a truncation fragment.

2. distal end: n = 7 (5 whole, 2 burned)

made on		whole	fragments
tert. flake	1	-	1
tert. bladelet	1	1	-
sec. b flake	4	3	1
sec. a flake	1	1	-
		5	2

All these retouched pieces are retouched partially on the distal end, mostly by small oblique or deep retouch, sometimes by larger retouch.

2. ventral retouch
   a. retouched edge
      1. nearly entire edge: n = 7 (3 whole, 1 burned)
         All three whole tools are secondary b fragments; two retouched on the right edge, one on the left, the latter one by flat medium retouch.

         The fragments are:

made on		ret. left edge	right edge
tert. flakes	2	1	1
tert. blades	1	1	-
sec. b flakes	1	-	1
		2	2

      2. less than half edge: n = 2 (1 whole)
         Both tertiary flakes have some small retouch in the middle of the left edge.

   b. retouched end
      1. proximal end: n = 1 (whole, burned)
         A tertiary flake was retouched partially along the platform and proximal end.

3. bifacial retouch
   a. retouched edge
      1. nearly entire edge: n = 4 (1 whole)
         The right edge of a secondary b flake was intensively bifacially retouched with accent on central retouch.

         The fragments are:

made on		ret left edge	right edge	unknown
tert, flakes	1	-	1	-
sec. b flakes	1	-	-	1
sec. a flakes	1	-	-	1
		-	1	2

4. <u>alternating retouch</u>
   a. retouched edge: n = 2 (1 whole)
      Both tools were made on tertiary flakes; one on the left edge, one on the right. The flaking on the fragment is more crude and larger than in the complete tool.

5. <u>other retouch</u>
   a. discontinuing retouch
      1. retouched edge: n = 1 (whole)
         One large tertiary blade was retouched along the left edge.

B. Pieces with bilateral retouch

1. <u>dorsal retouch</u>
   a. 2 retouched edges
      1. 2 nearly entire edges: n = 1
         The only tool fragment in this tool type was made on a tertiary flake with both edges irregularly retouched.

      2. 2 edges retouched partially, unequivalent loci: n = 1
         This tool fragment was made on a tertiary flake by small oblique retouch.

2. <u>ventral retouch</u>
   a. 2 retouched edges
      1. 2 nearly entire edges: n = 2 (1 whole, 1 burned)
         The Sa flakes were ventrally retouched, the heavy whole flake by very large and flat retouch, nearly covering the entire ventral face.

      2. 2 partial edges, equivalent loci: n = 1 (whole, burned)
         A Sb flake was retouched medial and proximal, more extensive on one edge than on the other.

3. <u>bifacial retouch</u>
   a. 1 edge and 1 end: n = 1
      1. A tertiary flake fragment was retouched regularly on the left edge and proximal end; there is some retouch in the middle of the right edge.

4. <u>alternating retouch</u>
   a. 2 edges, 1 retouched alternating: n = 3

made on		whole	fragment
tert. flakes	2	-	2
Sb flake	1	-	1
		-	3

5. alternate retouch
   a. 2 edges
      1. 2 nearly entirely retouched edges: n = 1
         This tool fragment was made on a tertiary flake.

      2. both edges partially retouched, equivalent loci:
         n = 1 (whole)
         The tool was made on a Sb flake, by small oblique retouch, near the proximal end on both edges. The edge outline is a little regular.

      3. both edges partially retouched, unequivalent loci:
         n = 1 (whole)
         This tool was made on a large and heavy tertiary flake.

   b. 1 edge and 1 end: n = 1 (burned)
      This tool fragment was made on a severely burned Sa flake by regular flat and oblique medium retouch.

6. other
   a. mixed bifacial and unifacial retouch
      1. 2 retouched edges: n = 2 (1 burned)
         One fragment was made on a tertiary flake, one on a Sb flake.

      2. 1 edge and 1 end: n = 1
         This tool fragment was made on a small tertiary flake fragment.

C. Multilateral pieces

1. bifacial retouch: n = 1 (burned)
   A small tertiary flake fragment was bifacially, marginally retouched on three edges by fine or small oblique retouch.

2. discontinuous retouch: n = 1 (whole)
   This tool was made on a thick Sb flake.

D. Special retouched pieces

1. pointed flakes and blades: n = 1 (whole?)
   A tertiary flake has a sharp point on the distal end. (The fact that there are several recent damage scars on both edges very near the point, is the reason why this tool was not included with the gravers.)

E. Unidentifiable fragments: n = 39 (15 burned)

These fragments were made on:

tert. flakes	20	chips	3
Sb flakes	8	chunks	3
Sa flakes	5		

X. Bifaces

All complete bifaces and preforms were recovered from area A, except two from area C.

A. Small triangular-subtriangular bifaces

1. with a concave base, thin in cross-section: n = 1
   A thin, regularly bifacially retouched small triangular biface, with a slight concave base was recovered from the Twin Sisters levels of this site. This tool is nearly identical to the one found at site 41WM258, likewise in a Twin Sisters context.

2. with a strongly convex base, thick in cross-section: n = 2
   Two small triangular bifacially retouched bifaces were found, one in Austin/Toyah context, one in a Twin Sisters context. The latter is a reworked older patinated bifacially retouched tool. On one face the tool was reworked at the base only while the other face only retains small patches of the older patinated surface.

   The other tool, made on a Sb flake, was bifacially retouched only at the base and part of one edge, with more small steep dorsal retouch along the same edge.

3. cruder larger artifacts, with a strongly convex base: n = 2
   One triangular and one subtriangular biface were found, respectively, in San Marcos and Austin/Toyah contexts. The former was made on a flake; a small part of the ventral face was preserved on one face. The base is thinned bifacially, the bifacial retouch on the edges is scaled.

   The other tool, damaged at the base, was made on a Sb flake. Part of the ventral face and some cortex on the dorsal face are preserved.

B. Medium to large bifaces

1. wide subtriangular bifaces, with convex edges: n = 1
   A slightly assymmetric biface, dated as Early Archaic, was made from an unusual grey-brown lightly spotted flint. The base is narrow compared to the maximal width of the tool. One edge was secondary unifacially retouched. The other edge is secondary bifacially retouched.

C. Preforms

1. less intensively worked preforms
   a. large void preforms: n = 2
      Both tools were made by large bifacial centripetal retouch; one retains some cortex on one face. One tool was recovered in Twin Sisters, the other in Early Archaic context.

2. <u>preforms with minimal retouch</u>
   a. crude, randomly worked artifacts: n = 1
      This biface/preform is a large tool, irregularly bifacially retouched by large centripetal retouch. Cortex is preserved on one face.

D. Biface Fragment

1. <u>basal fragments</u>
   a. with a more or less straight base, edges at right angles to the base: n = 2
      One fragment has extensive plow damage on one face, but this tool was a fragment of a very fine and carefully bifacially retouched tool, with extensive bifacial thinning of the base.

   b. with a more or less straight base, the edges at sharp angle to the base: n = 2
      These two fragments were both carefully retouched, but without basal thinning.

   c. with a more or less straight base, the edges at obtuse angle to the base: n = 5
      All five fragments recovered are well worked, although one is much thicker than the other fragments. One of its edges was flaked by secondary unifacial, intensive oblique retouch (bevelling).

   d. with a convex base: n = 3 (1 burned)
      All three fragments are rather thick, although all are carefully bifacially retouched on both edges. The base is more roughly retouched than the biface body, or sometimes not at all.

   e. special base fragments: n = 1
      This tool is a secondary, and unifacially retouched fragment on one edge, and with a notch in the opposite edge. The base and the rest of the edge are carefully bifacially retouched.

   f. unfinished basal fragments: n = 7 (2 burned)
      Four crudely retouched fragments, all retaining cortex, and three more carefully retouched fragments were found. Two of the former category, and a third one which was badly damaged still have a cortex base.

2. <u>top fragments</u>
   a. where the point forms an angle of 90°: n = 2 (1 burned)
      1. small fragments: n = 2 (1 burned)

2. large fragments: n = 3 (1 burned)
The fragment burned red is a long carefully retouched fragment, with one straight and one convex curved edge, forming together a sharp square point. (This fragment is possibly a basal fragment.)

b. biface fragments where the top forms a sharp angle
1. small fragments: n = 5 (2 burned)

2. large fragments: n = 17 (5 burned)
One fragment is a large and unusually thick (42 mm) very crudely retouched fragment. All its retouch is intensive, scaled in places, and the fragment is sharply pointed. Two other fragments show fairly steep bevelling near the tip, on one edge only.

c. biface fragments where the top forms an obtuse angle (wide)
1. large fragments: n = 1 (burned)

2. <u>medial fragments</u>
a. narrow fragments, the maximum width is less than 20 mm: n = 4
The largest fragment was made on a flake.

b. medium fragments, maximum width more than or equal to 20 mm and equal to or less than 40 mm: n = 10 (4 burned)
One fragment was made on a flake, and has some secondary unifacial steep small retouch on both edges.

c. large fragments, maximum width more than 40 mm: n = 2 (1 burned)
Both pieces are heavy, irregularly bifacially retouched fragments. The burned fragment is only partially burned.

3. <u>edge fragments</u>: n = 17 (13 burned)
The percentage of burned edge fragments (76.47%) is very high for this site. One fragment has some cortex left on one face.

4. <u>unidentifiable fragments</u>: n = 1

XIV. Chopping Tools: n = 3 (whole)

All three chopping tools have the bit as the only worked part of the tool, in each case by intensive large retouch. One tool, elongated in outline has a narrow bit, both other have a crude bit, one of which is quite intensively crushed.

Site 41WM133

I. Scrapers

A. Single endscrapers

1. single endscrapers on flake: n = 1
A single endscraper on a Sa flake was made by large to very large flat to oblique very regular dorsal retouch. The scraperbit has a rather low angle, and is the only part of the tool that is preserved.

B. Single sidescrapers

1. single sidescrapers on a flake: n = 1 (whole)
This tool was made on a tertiary flake, and its scraperbit is regularly retouched over nearly the whole edge by medium oblique dorsal retouch.

C. Double Scrapers

1. double scraper: n = 1 (whole)
A double sidescraper was manufactured on a large and heavily patinated Sb flake. The very high patina is only present on the non-retouched tool surface. Both scraperbits are formed by oblique to steep very large dorsal retouch.

D. Fragments: n = 1

There is only one fragment preserved at the site, probably part of the scraperbit of a sidescraper.

II. Denticulates

A. Denticulated pieces

1. denticulated flakes: n = 2 (whole)
Both tools were denticulated along one edge by steep to oblique dorsal retouch; one tool was made on a tertiary flake, the other one on a secondary b flake.

III. Notches

A. Single notches on flakes

1. single notch only: n = 2 (1 whole)
Both tools were made on tertiary flakes; the complete flake was notched in one edge by steep, fine dorsal retouch; the fragment was notched on the distal end by medium steep ventral retouch.

IV. Borer Tools

A. Gravers: n = 2 (whole)

The only two borer tools recovered from this site are of the "bec"-type. They are not very sharply pointed, but retouched into a rather square point of 90^{o}. Both were made by dorsal retouch, one on a tertiary flake fragment, the other one on a large secondary b flake. The latter tool was made in a coarser flint.

VIII. Burins

A. Angle burins

1. double angle burins: n = 1 (whole)
One double angle burin on snap on one extremity was made on an unidentifiable, broken projectile point base.

B. Oblique burins

1. single oblique burins: n = 1 (whole)
One single oblique burin was also made on a projectile point. The burin was made by a single oblique blow from the bifacially retouched edge of the point. Therefore, this could be an accidental burin, made on impact, rather than an intensional one.

IX. Retouched Pieces

A. Bilaterally retouched pieces

1. by alternating retouch
   a. two whole edges: n = 1
   A secondary b flake was retouched by dorsal retouch on the left edge and by ventral retouch along the right edge.

B. Multilaterally retouched pieces

1. mixed unifacial retouch: n = 2 (1 whole)
Both tools were made on secondary b flakes. One of them has two percussion bulbs, side by side. The retouch is rather irregular for both pieces.

X. Bifaces

A. Medium to large triangular to subtriangular bifaces
1. ovoid bifaces: n = 1 (burned)
This artifact is really only partially preserved although its outline is more or less intact. It has suffered severe fire damage and heatspalls removed a great deal of one surface and

a small part of the other. The tool is an elongated oval, bifacially retouched on all preserved edges. The least damaged face is regularly convex. Very little cortex is present.

B. Preforms

1. preforms with miscellaneous retouch
   a. crude, randomly worked artifacts: n = 1
      This artifact is very irregular in outline. These edges were irregularly bifacially retouched, one edge was unifacially retouched only. One face has entirely covering retouch, the other face has a great amount of cortex. It is possible that this artifact is a partially reworked core.

C. Biface fragments

1. basal fragments
   a. slightly pointed fragments: n = 1
      This tool fragment could possibly be the tip of a heavy 'pic', or other boring tool.

   b. unfinished basal fragments: n = 1
      This artifact was recovered from the 'general profile.' It is an irregularly bifacially retouched square basal fragment. All preserved edges were made by oblique, very large retouch.

2. top fragments
   a. large fragments: n = 1

3. edge fragments: n = 2

Site 41WM163

I. Scrapers

Only one scraper was recovered during excavation at this site, one other specimen was found on the surface, and two more came from the backhoe trenches.

A. Multiple scrapers: n = 2 (whole)

Both these multiple scrapers are single end- and double sidescrapers. The first one was made on a secondary b flake, and was retouched by large and irregular dorsal retouch; the tool has a scraper renewal scar on the ventral face, renewing the bit of the endscraper.

B. Other

1. <u>'giant' scrapers</u>: n = 1 (whole)
A damaged very large scraper was manufactured on a primary flake. In contrast with other 'giant' scrapers, this one has a pronounced convex scraperbit.

2. <u>microscrapers</u>: n = 1
This very small endscraper was made on the distal end of a tertiary flake, by small, steep dorsal retouch.

II. Denticulates

A. Denticulated pieces

1. <u>on blades, bladelets and microblades</u>: n = 1 (whole)
A secondary b bladelet was deeply denticulated by dorsal retouch in the middle of its right edge.

III. Notches

A. Single notches on flakes

1. <u>single notch only</u>: n = 3
Two dorsal and one ventral notch were made on tertiary flakes. All notches are located on the left edge.

2. <u>with additional continuous retouch</u>: n = 1
A tertiary flake was notched by dorsal retouch and has additional small dorsal retouch along most of the opposite edge.

B. Other

1. <u>meganotches</u>: n = 1 (whole)
A secondary b blade has a large irregular ventrally retouched notch in the middle of the right edge.

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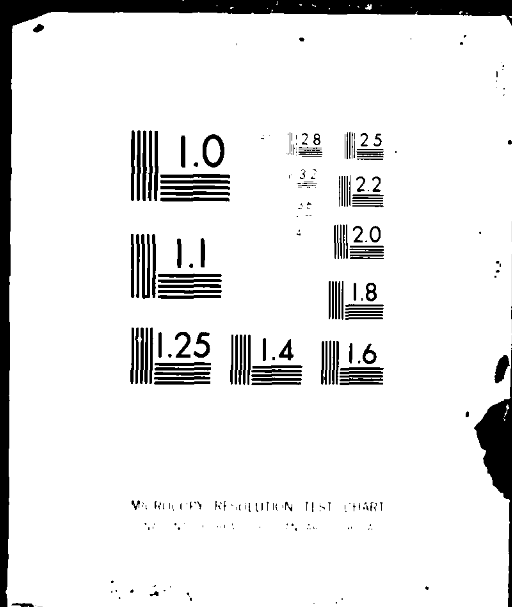


C. Fragments: n = 1

Part of a dorsally retouched notch is preserved on the edge of a tertiary flake fragment.

IV. Boring Tools

A. Gravers

1. oblique gravers: n = 1 (whole, burned)
The only graver found at this site is a finely retouched tool, with the sharply pointed graverpoint situated at an oblique angle to the length axis of the flake. The tool is made on a tertiary flake by fine oblique dorsal retouch.

B. Borers

1. borers on the flake or blade edge: n = 1
There was also only one borer recovered from this site; it was made on the edge of a small teritary flake by partially bifacial retouch.

C. Perforators

1. perforators on pointbase: n = 1 (whole)
The only perforator recovered from the site, was made on the point of a small projectile point, by bifacial secondary retouch on both edges. There is a noticeable narrowing of the width of the point-body in this area.

V. Truncations

A. Single distal truncations

1. dorsal retouch: n = 2
The larger tool, which lacks only a small part of the proximal end, is an oblique, slightly concave truncation. It was manufactured on a tertiary flake. The other fragment is small, but contains an undamaged truncated distal end of a tertiary (?) flake.

2. ventral retouch: n = 1 (whole)
This tool has an oblique ventral truncation, made on a tertiary flake.

B. Single proximal truncations

1. dorsal retouch: n = 2 (whole)
Both pieces were made on tertiary flakes by steep small to medium retouch. The larger tool has additional dorsal retouch over all other edges.

C. Fragments: n = 1

This fragment was part of a dorsal distal truncation on a secondary b flake by oblique to steep small retouch.

VI. Backed pieces

A. One whole edge is backed

1. straight or slightly convex edge
   a. *dorsal retouch:* *n* = 1 (whole)
      A Sb flake was backed on the right edge by steep medium to large retouch

B. One edge is partially backed

1. dorsal retouch: n = 1 (whole)
   The medial part of this secondary b bladelet was backed straight by steep dorsal retouch.

C. Fragments: n = 1

This tool fragment is a Sb flake dorsally backed on the right edge.

VII. Burins

A. Dihedral burins

1. dihedral burin on angle: n = 1 (whole)
   The only burin recovered from this site is a single dihedral burin on angle, made on a projectile point fragment.

IX. Retouched pieces

A. Pieces with unilateral retouch

1. dorsal retouch
   a. retouched edge
      1. nearly entire edge: n = 5 (2 whole)
         For the whole pieces, one tertiary flake has a retouched right edge, a larger Sb flake a retouched left edge. All three fragments are Sb flakes; one retouched on the left, two on the right, one of which has a distinctively concave edge.

      2. less than half edge: n = 4 (2 whole, 1 burned)
         Both complete tools are Sb flakes, one retouched on the left edge, the other on the right one, both in the medial part, by small oblique retouch. Both fragments are Sb flakes retouched on different edges also; one on the proximal part, the other one on the distal part.

b. retouched end

1. distal end: n = 5 (4 whole, 1 burned)

made on		whole	fragment
tert. flakes	4	3	1
Sb flakes	1	1	-
		4	1

All tools except one are retouched by oblique to steep small dorsal retouch. A large Sb flake was irregularly retouched by small to medium oblique retouch.

2. ventral retouch

a. retouched edge

1. nearly entire edge: n = 7 (6 whole, 4 burned)
The complete tools are:

made on		left edge	right edge
tert. flakes	3	3	-
Sb flakes	1	-	1
Sa flakes	1	-	1
primary flakes	1	1	-
		4	2

Large flat retouch was used only on the heavy primary flake, all other flakes have small oblique retouch. The tertiary flakes are small, and all burned. The one fragment is a very small tertiary flake, retouched on the left edge.

2. less than half edge: n = 1 (whole)
A Sb flake has proximal retouch on the left edge.

b. retouched end

1. distal end: n = 1
This tool is a small part of a tertiary flake with fine oblique to steep ventral retouch.

3. alternating retouch

a. retouched edge: n = 1 (burned)
A tertiary flake was flaked by altern[illegible] small oblique retouch on the left edge.

B. Pieces with bilateral retouch

1. dorsal retouch

a. 2 retouched edges

1. 2 nearly entire edges: n = 2 (1 whole)
The tools were:

made on		whole	fragments
tertiary flakes	2	1	1

The flake fragment has oblique retouch; the complete tool has steeper retouch, also small to medium.

2. 2 edges partially, equivalent loci: n = 1 (whole, burned)
   Both edges of this tertiary flake were steeply retouched near the proximal end.

b. 2 edges partially, unequivalent loci: n = 1 (whole, burned)
   A secondary b flake has medial and distal retouch, the latter a very fine retouch.

2. alternate retouch
   a. 2 edges
      a. 2 nearly entirely retouched edges: n = 1
         This secondary b flake is irregularly retouched on one edge, regular on the other.

   2. both edges partially retouched, unequivalent loci: n = 2 (1 burned)
      Both fragments were made on Sb flakes.

3. other
   a. mixed bifacial and unifacial retouch
      1. 2 retouched edges: n = 1
         This fragment was made on a Sb flake.

   b. discontinuous retouch
      1. 2 edges: n = 3 (whole)
         Two tools were made on Sb, one on a Sa fragment. All flakes are heavy, and roughly retouched.

C. Multilateral pieces

1. mixed bifacial and unifacial retouch
   a. 2 edges and 1 end
      1. 1 edge bifacially retouched: n = 1
         The bifacial retouch on one edge of this Sb flake is regular, all other flaking is irregular.

2. discontinuous retouch: n = 1 (whole, burned)
   This retouched pieces was made on a heavy secondary flake by very rough and irregular flaking.

D. Unidentifiable fragments: n = 17 (3 burned)

These fragments were made on:

tertiary flakes	12	chunk	2
Sb flakes	4		

X. Bifaces

A. Small bifaces, triangular and subtriangular

1. with a strongly convex base, thick in cross-section: n = 1
This small biface has secondary bifacial retouch on the base and one edge, forming sharp cutting edges.

2. with a strongly convex base, thick in cross-section: n = 1 (burned)
One triangular biface was recovered from the surface, has extensive plow scars, and is also damaged at the tip of the biface. Both edges are carefully retouched, and the base has partial secondary unifacial retouch.

B. Medium and large bifaces

1. elongated triangular bifaces, medium length: n = 1
This long, narrow biface is sharply pointed at one end, and has convex edges. One edge and the base were carefully bifacially retouched; the other edge is a fracture plane from where both faces of the tool were retouched, although the edge itself was not modified.

C. Miscellaneous

1. elongated quadrangular bifaces: n = 1
The tool is a small, completely bifacially retouched, narrow and long. All edges are carefully bifacially retouched, and the base was bifacially thinned. Both edges are smooth from the base to 1/3 of this length.

D. Preforms

1. intensively worked performs
   a. medium-sized, without a pointed extremity: n = 1
   The biface was made by irregular large centripedal bifacial retouch. Small amounts of cortex are present on one face.

   b. medium-sized elongated, without a pointed extremity: n = 1
   The biface is intensively worked by irregular bifacial retouch on both edges and top; the base is cortex covered. The retouch is somewhat crushed in places.

2. less intensively worked preforms
   a. medium-sized and large, elongated, one extremity slightly pointed: n = 2
   Both tools are very irregular, made by bifacial and occasionally unifacial retouch. One biface was thinned on the base.

b. rectangular preforms: n = 1
This is a very roughly retouched tool, possibly on core. The base is cortex covered.

c. large ovoid preforms: n = 1
Both edges and part of the base of this biface were roughly bifacially retouched. The cortex and other natural surface are preserved on top and base.

3. preforms with minimal retouch
a. crude, randomly worked preforms: n = 1
Both edges of the biface are unifacially retouched both extremities are bifacially retouched. It is also unclear if this artifact is an unfinished biface or a core.

E. Biface fragments

1. basal fragments
a. basal fragments with a more or less straight base, the edges at sharp angles to the base: n = 2
Two such fragments were recovered from this site, both carefully retouched. The larger fragment has extensive bifacial basal thinning.

b. basal fragments with convex base: n = 3
The largest fragment is very crudely retouched; another fragment is a nearly complete small biface, made on an older deeply patinated flake. Both edges are bifacially retouched, and only the base has been retouched a little. This tool may be a small projectile point.

c. unfinished basal fragments: n = 1
One such fragment was crudely bifacially retouched with cortex still remaining on one edge.

2. top fragments
a. biface fragments where the top forms a sharp angle
1. small fragments: n = 3
One fragment is from a very sharply pointed flake of which one edge is slightly serrated.

2. large fragments: n = 6 (1 burned)
The burned fragment is very elongated.

3. medial fragment
a. narrow fragments: n = 2
One serrated fragment has relatively long and sharp retouch and is possibly an arrowpoint fragment.

b. medium fragments: n = 5 (3 burned)

4. <u>edge fragments</u>: n = 5 (1 burned)

XIII. Axes

A. Bifacially retouched axes, with a straight bit profile: n = 2

One axe is an intensively worked, completely bifacially retouched tool with a convex bit, straight in profile. It closely resembles some other axes recovered at other sites, but the straight bit profile is unique.

The other axe is a roughly retouched, oval tool. It was made on an older tool, deeply patinated, and was resharpened at the bit only, by relatively few, bifacial retouch.

XIV. Chopping tools: n = 1 (whole)

This chopping tool was recovered from the surface. It is a medium sized pebble, of which one small end was intensively bifacially retouched by very large flakes.

XV. Scaled and battered pieces: n = 1 (whole)

A large tertiary flake has intensive scaled retouch over a small part distal on the right edge. The edge appears to be slightly battered.

Site 41WM230

I. Scrapers

Eleven scrapers were recovered from excavation, one from a backhoe trench.

A. Single endscrapers

1. single endscrapers on flake: n = 2 (whole)
Of two single endscrapers one was made on a natural flake, one on a Sb flake; the latter having the concave scraper bit on the proximal end made by oblique to steep medium to large dorsal retouch.

2. single endscrapers on retouched flake: n = 2 (1 whole)
A whole single endscraper and a fragment of one were both made on retouched tertiary flakes. Both have the distal end retouched by steep medium-sized dorsal retouch, the latter also has a flat ventral preparation. The first specimen has some additional dorsal retouch on the left edge.

3. denticulated endscrapers: n = 1
A fragment of a denticulated scraper was made on a natural flake by steep to oblique, medium to large dorsal retouch.

B. Single sidescrapers

1. single sidescrapers on flake: n = 2 (whole)
A complete single sidescraper was manufactured by steep small to medium dorsal retouch on the left edge of a Sb flake.

A concave single sidescraper was made on the right edge of a Sb blade by oblique to steep medium to large dorsal retouch. Unfortunately this tool was found in backhoe trench spoil so that it's cultural affiliations are lost.

2. inverse scraper: n = 1 (whole)
As the previous tool but made by ventral retouch.

C. Double scrapers

1. single end- and single sidescrapers: n = 1 (whole)
One single end- and single sidescraper, made on a Sb flake, had its scraper bits formed by oblique steep, medium to large dorsal retouch.

D. Multiple scrapers: n = 1 (whole)
A multiple scraper was made on a natural flake by steep dorsal retouch. Most of the dorsal face was covered by cortex.

E. Other.

1. microscrapers: n = 2 (whole)
Two microscrapers were recovered from this site; one in Twin Sisters; one in Neo-American levels. Both were made on tertiary microflakes, one by steep, the other by perpendicular small dorsal retouch. One tool had the scraperbit on the proximal end; the other on the distal end.

II. Denticulates

A. Serrated pieces

1. partially serrated flakes: n = 2
Two tertiary flake fragments were finely serrated, both by dorsal retouch. One flake was retouched on part of one edge and also on part of the distal end; the retouch is very fine and regular. The other tool was retouched only on a very small part of the left edge.

B. Denticulated pieces.

1. denticulated flakes: n = 2 (1 whole)
The whole tool was made on a secondary b blade by small to medium ventral retouch. The denticulation of this tool is very shallow. The other fragmentary tool was made on a tertiary flake, and only a small part of the edge was denticulated by medium dorsal retouch.

2. crudely denticulated pieces: n = 2 (1 whole, 1 burned)
Both tools were made by very rough and irregular large to very large dorsal retouch; one on a secondary a flake, the other one on a secondary b flake.

C. Unidentifiable fragments: n = 2
Both tools were made on secondary b flakes; one by bifacial retouch, the other one by dorsal retouch. The latter one was denticulated on both edges.

III. Notches

A. Single notches on flakes.

1. notched flakes: n = 13 (7 whole)
Most single notched tools were made on tertiary flakes or tertiary flake fragments. Seven notches were made by dorsal

retouch, the other ones by ventral retouch. This retouch varies from small and carefull to large, sometimes irregular retouch. The notches usually occur on the edges, but sometimes also on the distal end. Seldom do notches occur on the proximal end.

2. single notches with additional continuous retouch: n = 1
A tertiary flake fragment was notched on the distal end by steep, small, dorsal retouch, and was also retouched on the left edge by steep, medium to large dorsal retouch.

B. Notched blades, bladelets and microblades

1. *single notched pieces:* n = 1 (whole)
A tertiary bladelet was notched on one edge by steep small ventral retouch.

IV. Boring Tools

A. Gravers

1. gravers on flake-axis: n = 1 (whole)
One graver was made on the axis of a Sb flake by regular oblique to steep dorsal retouch.

2. gravers on flake edge: n = 3 (1 whole)
Of these "beaked" gravers made on a flake edge, two are made on tertiary flakes, one on a Sb flake; the latter made by ventral retouch, the other by dorsal retouch. Two tools are only fragments.

3. oblique gravers: n = 1 (whole)
One oblique graver was made on the distal end of a flake by oblique to steep dorsal retouch. The graver point is not very sharp and rather squared.

B. Other borer tools

1. pics: n = 2
Two roughly pointed and retouched tools were recovered at this site. One is made on a very large Sb blade by steep intensive dorsal retouch, distinctly narrowing; unfortunately, the distal extremity of this tool is not preserved. The other fragment is a bifacially retouched fragment, equally elongated, with strong alternate edge beveling.

retouch, the other ones by ventral retouch. This retouch varies from small and carefull to large, sometimes irregular retouch. The notches usually occur on the edges, but sometimes also on the distal end. Seldom do notches occur on the proximal end.

2. single notches with additional continuous retouch: n = 1
A tertiary flake fragment was notched on the distal end by steep, small, dorsal retouch, and was also retouched on the left edge by steep, medium to large dorsal retouch.

B. Notched blades, bladelets and microblades

1. single notched pieces: n = 1 (whole)
A tertiary bladelet was notched on one edge by steep small ventral retouch.

IV. Boring Tools

A. Gravers

1. gravers on flake-axis: n = 1 (whole)
One graver was made on the axis of a Sb flake by regular oblique to steep dorsal retouch.

2. gravers on flake edge: n = 3 (1 whole)
Of these "beaked" gravers made on a flake edge, two are made on tertiary flakes, one on a Sb flake; the latter made by ventral retouch, the other by dorsal retouch. Two tools are only fragments.

3. oblique gravers: n = 1 (whole)
One oblique graver was made on the distal end of a flake by oblique to steep dorsal retouch. The graver point is not very sharp and rather squared.

B. Other borer tools

1. pics: n = 2
Two roughly pointed and retouched tools were recovered at this site. One is made on a very large Sb blade by steep intensive dorsal retouch, distinctly narrowing; unfortunately, the distal extremity of this tool is not preserved. The other fragment is a bifacially retouched fragment, equally elongated, with strong alternate edge beveling.

V. Truncations

A. Single distal truncations

1. dorsal retouch: n = 3 (2 whole)
One straight, one oblique straight and one oblique concave truncation were all made on tertiary flakes by steep to oblique small dorsal retouch.

2. ventral retouch: n = 1 (whole)
On a partially deeply patinated secondary a flake, the distal end was truncated straight by olbique medium ventral retouch.

B. Single proximal truncations

1. dorsal retouch: n = 1
A small fragment of a tertiary flake was truncated straight by steep small dorsal retouch.

VI. Backed Pieces

A. One entire edge backed

1. straight or slightly convex backed edge
a. dorsal retouch: n = 4 (1 whole, 1 burned)
One whole tool was made on a tertiary microblade, another one on a tertiary blade fragment. The two other tools were both made on secondary flake fragments, one secondary a and one secondary b flake. For all tools the retouch is steep and small.

b. ventral retouch: n = 2 (1 whole)
The whole tool was made on a secondary b flake, the fragment was tertiary. This last tool had some additional fine ventral retouch along the distal end of the flake. The backing re- touch was steep and small for both tools.

2. convex backed edge
a. dorsal retouch: n = 1
This tool was made on a tertiary flake proximal fragment by steep, medium to large more or less lamellar retouch.

B. One edge partially backed

1. dorsal retouch: n = 10 (5 whole, 2 burned)
Most of the partially backed pieces were made on tertiary elements, two on blades, three on microblades, and four on flakes. One secondary a and one secondary b flake were also used. Most tools were not backed either on the proximal or on the distal extremity of the flake. Only one flake was retouched in the medial part of one edge only, and not at

either extremity. The backing retouch is always steep, and usually small. A few tools have medium retouch.

2. ventral retouch: n = 2 (1 whole)
Both tools were made on tertiary flakes by small steep retouch, and both were backed on the distal end of the edge only.

VII. Burins

A. Angle burins

1. single angle burins
a. on snap: n = 5 (whole)
Five single angle burins were made on snap, two on broken projectile point bases, two on secondary b flakes, and one on a tertiary flake.

b. from an unaltered platform: n = 5 (whole)
Five other single angle burins were made from unaltered flake extremities. Two tools were made from the platform of secondary b flakes, one of which was produced by multiple burin spalls. Three other burins were produced from the unaltered cortex distal end of one secondary a blade and two secondary b flakes.

2. double angle burins: n = 1 (whole)
The only double angle burin was made on a straight distal truncation, on a secondary a flake. The retouch for the truncation was steep to oblique, and made by large, dorsal retouch. Both distal corners of the truncation were used as platforms for the burin spalls.

B. Dihedral burins

1. dihedral burins on axis: n = 1 (whole)
One single dihedral burin was made on the distal end of a secondary b flake.

2. dihedral burins on the flake edge: n = 1 (whole)
One single dihedral burin was made on the left edge of a secondary b flake by two burin spalls, one towards the distal end, and one towards the proximal end of the flake. This tool is a very unusual form of burin.

C. Transversal burins

1. single transversal burins: n = 1 (whole)
One single transversal burin was made from the unaltered left edge of a secondary b flake. The flake's edge was naturally perpendicular and was used as a platform for burin spall removal.

IX. Retouched pieces

A. Pieces with unilateral retouch

1. dorsal retouch

a. retouched edge

1. nearly entire edge: n = 12 (3 whole)
The complete tools are

made on		ret. left edge	right edge
tertiary flake	1	1	-
tertiary blade	1	-	1
secondary b flake	1	1	-
	3	2	1

The retouched edge is always made by small to medium oblique regular retouch. Mostly the retouch occurs from the middle to the distal part of the flake. The blade also has some recent damage.

The fragments are

made on		ret. left edge	right edge
tertiary flake	4	1	3
secondary b flake	4	3	1
secondary b natural flake	1	-	1
	9	4	5

The retouch on the fragmentary artifacts is much the same as for the complete pieces. One fragment is probably a fragment of another tool; another fragment might be a scraper fragment.

2. less than half the edge: n = 15 (5 whole, 5 burned)
The whole tools are

made on		ret. left edge	right edge
tertiary flake	2	-	2
tertiary blade	1	1	-
secondary b flake	1	1	-
secondary a flake	1	-	1
	5	2	3

Retouch is always fine to small oblique flaking over a small part of the flake edge. The blade was naturally pointed.

The fragments are

made on		ret. left edge	right edge
tertiary flake	5	3	2
secondary b flake	2	1	1
secondary a flake	3	2	1
	10	6	4

As for the whole artifacts, most tools are retouched obliquely with fine or small retouch along a small part of their edge.

b. retouched edge

1. proximal end: n = 1 (whole)
A whole tertiary flake was retouched by small oblique to steep retouch along part of its proximal end.

2. distal end: n = 12 (7 whole)
The tools are

made on		whole	fragment
tertiary flakes	6	4	2
tertiary microflakes	1	1	-
secondary b flakes	5	2	3
	12	7	5

Retouch is usually small oblique flaking along most of the distal end. In very few cases this retouch only covers part of the distal end. One artifact is damaged on its distal end, and only part of its retouch is preserved.

2. <u>ventral retouch</u>

a. retouched edge

1. nearly entire edge: n = 9 (5 whole, 2 burned)
The whole tools are

made on		ret. left edge	right edge
tertiary flake	2	1	1
secondary b flake	3	2	1
	5	3	2

Two secondary b flakes have medium to large oblique ventral retouch; two other pieces are made by small retouch. One tertiary flake ahs crushed retouch.

The fragments are

made on		ret. left edge	right edge
tertiary flake	2	1	1
secondary b flake	2	1	1
	4	2	2

Retouch in all the above fragments are medium to large oblique retouch, except in one instance where retouch is flat.

2. less than half edge: n = 7 (1 whole, 1 burned)
The only complete tool was made on the left edge of a secondary b flake.
The fragments are

made on		ret. left edge	right edge
tertiary flakes	3	-	3
secondary b flakes	3	2	1
	6	2	4

Retouch on most pieces is small oblique, regular retouch, along a small part of the edge.

b. retouched end
1. proximal end: n = 2 (1 whole)
Both artifacts were made on tertiary flakes by oblique small retouch. Part of the bulb and platform were removed.

2. distal end: n = 3 (1 whole, 1 burned)
The whole flake was made on a tertiary flake, one fragment was made on a secondary b flake, the other one on a tertiary flake. This last tool was retouched on the distal extremity after the latter was fractured.

3. bifacial retouch
a. retouched edge
1. nearly entire edge: n = 1
The only tool with one entirely bifacially retouched edge recovered from this site was made on a tertiary flake fragment. The retouch varies from small to large and is crushed and sealed in places. This retouched right edge is the only one preserved.

b. retouched end
1. proximal end: n = 1
This artifact is also unique at this site. The retouch is bifacial but more prominent on the ventral face where large flat retouch removed

most of the bulb. The tool was made on a tertiary flake fragment.

2. distal end: n = 1 (burned)
The distal end of this secondary flake was retouched bifacially, especially flat on the ventral face by medium to large retouch.

4. alternating retouch
   a. retouched end: n = 1 (whole, burned)
   This artifact is made on a secondary b flake by small oblique and regular retouch.

5. other retouch - mixed bifacially and unifacially
   a. retouched edge: n = 2 (1 whole, 1 burned)
   One tool is made on a tertiary flake, the other one on a secondary b flake. Both are made on the left edge by flat medium and large to irregular retouch.

6. discontinuing
   a. retouched edge: n = 4 (3 whole)
   These artifacts were

made on		whole	fragments
tertiary flake	1	1	-
tertiary blade	1	-	1
secondary b flake	1	1	-
secondary b blade	1	1	-
	4	3	1

The secondary b blade is naturally cortex backed along one edge, while in the middle of the other edge irregular flat retouch occurs which resulted from use.

The teritary blade is only slightly damaged by extensive recent fracturing. This artifact and the other two have discontinuous irregular ventral and/or dorsal retouch along part of one edge. Most if not all tools exhibit use retouch.

B. Pieces with bilateral retouch

1. dorsal retouch
   a. retouched edges
      1. one nearly entire edge and one edge partially: n = 2 (1 whole, 2 burned)
      The fragmentary tool was made on a tertiary flake by oblique to steep retouch of varying sizes. This fragment

is badly burned, but it is possible that this was part of a scraper.

The complete tool was made on a secondary b flake by intensive steep, and somewhat crushed, retouch. This piece appears to be patinated and eolised.

2. edges partially, equivalent loci: n = 1
This artifact was made on a proximal tertiary flake fragment by regular oblique retouch in the middle of both edges.

3. 2 edges partially, unequivalent loci: n = 3 (whole)
The artifacts are

made on		whole	fragment
tertiary flake	1	-	1
tertiary bladelet	1	1	-
secondary b flake	1	-	1
	3	1	2

The tertiary bladelet was retouched proximally on one edge distal on the other, the latter retouch blunting the distal extremity.

Both of the other tools are retouched medially on one edge, distally on the other.

b. one edge and one end retouched

1. both partially: n = 3 (1 whole)
The artifacts were

made on		whole	fragment
tertiary flake	2	1	1
secondary b flake	1	-	1
	3	1	2

The retouched end is adjacent to the part of the edge which was retouched, i.e., both tertiary elements were retouched along part of the distal end and the distal extremity of one edge. The secondary element was retouched proximally.

2. both nearly entirely retouched: n = 1 (burned)
This artifact was made on a secondary b flake by irregular oblique medium retouch. The retouch occurs on the distal end and the right edge.

2. ventral retouch
   a. 2 retouched edges
      1. two nearly entire edges: n = 1
         This artifact was made on a primary flake fragment by medium to large, oblique to flat retouch. Both edges were retouched along their entire length.

      2. both edges partially, equivalent loci: n = 1
         This tool was made on a tertiary bifacial thinning flake by regular small to medium retouch. Both edges are retouched medially, extending a little proximally on the left edge.

3. bifacial retouch
   a. 2 edges: n = 3
      All tools were made on tertiary elements. Two artifacts are more or less regularly bifacially retouched along the entire length of both edges. One of these comes very close to a biface preform.

      The third tool is only partially retouched on the distal end of both edges.

4. alternate retouch
   a. 2 edges
      1. one edge partially, one entirely retouched: n = 2
         Both artifacts were made on tertiary flakes by olbique small to medium retouch. One tool is nearly complete.

      2. both edges partially, equivalent loci: n = 1
         This artifact was made on a tertiary flake fragment. Both edges were retouched on their proximal part by small oblique retouch.

   b. one edge and one end: n = 4 (1 whole, 1 burned)
      These artifacts are

made on		whole	fragment
tertiary flake	2	-	2
tertiary bladelet	1	-	1
secondary b flake	1	1	-
	4	1	3

      Most artifacts were retouched along the distal end and one edge. For the bladelet the edge retouch was partial only. The retouch is usually small or medium oblique retouch except in the secondary b flake where there is some large to very large flat ventral retouch. One tertiary flake fragment was retouched on its proximal end.

5. <u>other</u>
   a. mixed bifacial and unifacial retouch
      1. two retouched edges: n = 1
         This artifact was made on a secondary b flake. Both edges were retouched in their medial part by bifacial retouch on the right edge, some very large dorsal retouch on the left edge.

C. Pieces With Multilateral Retouch

1. <u>dorsal retouch</u>: n = 1
   This artifact wasmade on a tertiary flake fragment by small oblique retouch. Both edges were only partially retouched, one distal and the other one proximal.

2. <u>mixed bifacial and unifacial retouch</u>
   a. two edges and one end: n = 2
      One tool was made on a tertiary flake fragment, the other one on a secondary b flake fragment. The former was made by regular small to medium retouch, the other one by very irregular retouch.

D. Special retouched pieces

1. *pointed flakes and blades*: n = 4 (2 whole, 1 burned)
   These artifacts are

made on		whole	fragment
tertiary flake	1	-	1
secondary b flake	2	2	-
secondary a flake	1	-	1
	4	2	2

None of these tools were retouched into a point. Some artifacts are naturally pointed, some were retouched along one edge forming a point. Two tools are pointed at the proximal end, the other two on the distal end. The former two are also slightly shouldered.

The retouch is usually unifacial, either ventral or dorsal, and regular in most cases.

E. *Unidentifiable fragments*: n = 22 (4 burned)
These fragments were made on:

tertiary flakes	14	secondary b flake	1
tertiary microblade	1	secondary a flake	1
tertiary heatspall	1		

X. Bifaces

The complete bifaces and possibly unfinished bifaces ('preforms') are treated differently for this site. This is due to the fact that at the time our biface typology was set up and worked out the Loeve-Fox tools were no longer in our possesion, but were returned to UT-Austin. It seems inappropriate for us to integrate the bifaces from this site into the typology, using the data available in our notes only, without examining the artifacts themselves again. Consequently, the artifacts are grouped into some larger groups, for easy comparisions with other sites.

We will also not attempt a detailed description per subtype, for the same reasons. Examination of these artifacts in a more general way, however, indicates that the variations within this tool class are as great as noticed for the rest of the assemblage. Tools range from very carefully retouched artifacts to only perfunitory retouched tools.

A. Bifaces

1. small bifaces: n = 12 (1 burned)
   Most of the small bifaces are triangular to subtriangular in outline, with bases varying from concave, to straight to convex, to strongly convex. Usually the other extremity is pointed.

2. medium to large bifaces: n = 8 (1 burned)
   The large bifaces are much as the small ones, mostly triangular and subtriangular in outline. Most have a convex base, some have a straight base. Only one artifact has a concave base, and is distinctly assymmetric; one edge is nearly straight, the other one convex, especially near the top.

3. other bifaces: n = 6
   These include all the other bifaces in the typelist not included above.

   These tools are large avoid bifaces, all partially battered; two along both their narrower edges, the third one along part of one edge (after retouch). All three occurred in the Twin Sisters levels.

   We have not found similar tools at the other sites.

   One artifact is a subtriangular tool with strongly convex base, finely serrated along both edges to a sharp point. The edges are slightly bevelled. A fifth artifact is a narrow elongated rectangular biface bifacially retouched along all edges.

The last biface in this category is a unique bipointed tool. While the retouch in the middle of both edges is very rough and irregular, both extremities are rather carefully retouched with almost lamellar retouch in places.

B. Preforms: n = 15 (2 burned)
Most preforms are large avoid tools, irregularly bifacially retouched along their edges. Some are pointed, most are not. There are a few irregular forms. One is a medium sized avoid tool, with distinct notches at the same height on both edges, possibly for hafting. Another tool is overall deeply patinated white, except in one place were a more recent retouch created a regular concave edge. This last tool certainly appears to be unfinished.

C. Biface Fragments

1. <u>basal fragments</u>
   a. with a more or less straight base, the edges at right angles: n = 2
   One of these fragments is relatively long and narrow.

   b. with a more or less straight base, the edges at sharp angles: n = 2
   One of the tools is nearly complete, and lacks only its point; the edges are at a very sharp angle to the base. The tool was a triangular biface.

   c. with a more or less straight base, the edges at obtuse angle: n = 8
   One of the fragments is also relatively narrow, very similar to the one mentioned above. Another fragment is very large and very wide. Two fragments are missing, one of the basal corners, as well as the top part of the biface.

   d. with a strongly convex base: n = 6
   Most fragments are carefully retouched, and one is extremely well bifacially retouched. One fragment is part of a very large, very wide biface.

   e. with a slightly concave outline: n = 8 (1 burned)
   Several of these basal fragments were also extremely carefully bifacially retouched, and some were also thinned at the base. The basal concavity is never very deep.

   f. pointed basal fragments: n = 3
   Two fragments have what could be a long and narrow stem, its maximum width close to the width of the biface body. The third tool fragment tapers towards a pointed extremity, and could perhaps be a top fragment.

g. unfinished basal fragments: n = 4 (2 burned)
All of these biface fragments are roughly, bifacially retouched toolparts, and were probably fragments of unfinished bifaces.

2. <u>top fragments</u>
   a. fragments where the top forms an angle of less than 90^{o}
      1. small fragments: n = 6

      2. large fragments: n = 30 (2 burned)
         Nearly all these fragments were carefully bifacially retouched; only two fragments were roughly, but also bifacially retouched.

   b. fragments where the top forms an angle of more than 90^{o}
      1. large fragments: n = 1
         This fragment is probably a basal corner fragment.

3. <u>medial fragments</u>
   a. narrow fragments, width less than 20 mm: n = 9 (4 burned)

   b. medium fragments, width more than or equal to 20 mm and equal or less than 40 mm: n = 13 (4 burned)
      One of the fragments was serrated along both edges. Most fragments were carefully retouched by regular bifacial retouch, few were only roughly primarily flaked.

   c. wide fragments, the maximum width more than 40 mm: n = 6
      Most of these fragments were also carefully and regularly bifacially retouched.

4. <u>edge fragments</u>: n = 1 (burned)

5. <u>unidentifiable fragments</u>: n = 3 (1 burned)

XIV. Chopping Tools: n = 5 (whole)

These artifacts are all made on medium to large modules, all but one still covered with cortex are a large part of their surface. One narrow extremity was bifacially retouched. Some by careful bifacial retouch, but mostly by a rough and irregular flaking. One artifact was not only retouched on the bit, but also along part of the edges and the base, but this retouch has an older patina than the rest of the artifact. Most tools are carefully made artifacts; one is a very heavy and crude tool.

XVI. Unifacials: n = 2

One tool was made on a tertiary flake fragment, retouch covering the dorsal face by flat large dorsal retouch. No retouch at all was present on the ventral face.

Site 41WM258

I. Scrapers

A. Endscrapers

1. inverse endscrapers: n = 1 (whole)
The single endscraper was made on a heavy secondary a flake by intensive ventral retouch.

II. Denticulates

A. Serrated pieces: n = 1 (whole)

A Sb flake was sharply serrated by fine, mostly dorsal retouch on its right edge.

B. Denticualted pieces

1. denticulated flakes: n = 1 (whole)
The distal end of this Sa flake was steeply dorsally retouched almost as a denticulated endscraper. There is some irregular bifacial retouch on the proximal end of the tool.

III. Notches

A. Multiple notches on flakes

1. large and crude notched pieces: n = 1
A heavy secondary b flake has two adjacent notches on its right edge, both made by a few large dorsal retouches.

IV. Boring Tools

A. Gravers

1. oblique gravers: n = 1 (whole)
The only graver recovered from this site is a square tipped graver made on the right distal corner of a tertiary flake. The tool's point was formed by a small, straight edge and a notch, all dorsally retouched.

B. Borers

1. borers on axis: n = 1 (whole)
The only borer recovered from this site was made on secondary b flake, by alternate retouch. The borer point was made by oblique, partially covering, medium retouch; ventral on the right edge, dorsal on the left edge.

14-212

VII. Burins

A. Angle Burins

1. single angle burins
   a. on snap: n = 1 (whole)
      This tool is made on a point fragment.

B. Oblique burins

1. single oblique burins, from an unretouched edge: n = 1 (whole)
   This tool is an inverse oblique burin, made by multiple burinspalls on a tertiary flake. The burin has fine, regular retouch over the whole length of the right edge, almost flat near the proximal end, but gradually steeper towards the distal end. Ventral oblique retouch begins halfway on the edge towards the distal end.

IX. Retouched pieces

A. Pieces with unilateral retouch

1. dorsal retouch
   a. retouched edge
      1. almost entire edge: n = 3 (1 burned)
         Two tertiary and one Sb flake fragment are the only pieces in this category recovered from this site; two are retouched on the left edge, the tertiary fragment on the right edge.

   b. retouched end
      1. distal end: n = 1 (whole)
         The distal end of a tertiary flake was retouched, but there is extensive recent damage so as to make it difficult to distinguish exactly how far the original retouch extended.

2. ventral retouch
   a. retouch edge
      1. nearly entire edge: n = 1
         A fragment of a Sb flake is retouched obliquely on the right edge.

B. Pieces with bilateral retouch

1. dorsal retouch
   a. 2 retouched edges
      1. 2 nearly entire edges: n = 1
         The only tool fragment in this category was made on a tertiary flake with both edges damaged.

2. <u>other</u>
   a. mixed bifacial and unifacial retouch
      1. 2 retouched edges: n = 1
         A Sb flake was retouched irregularly on both edges by small and medium low to flat retouch.

   b. discontinuous retouch
      1. 2 edges: n = 2 (1 burned)
         Both fragments were made on tertiary flakes.

C. Unidentifiable fragments: n = 1 (burned)

This fragment was made on a tertiary flake.

X. Bifaces

A. Small, triangular or subtriangular bifaces

1. <u>bifaces, with a concave base, thin cross-section</u>: n = 1 (burned)
   A regular, bifacially retouched small triangular biface was recovered in Twin Sisters component context. The biface is sharply pointed, and is slightly damaged by fire. The only other very similar tool was found at site 41WM124.

2. <u>bifaces, with a straight or slightly convex base, thin cross-section</u>: n = 2
   Of these two small triangular bifaces, one was found in an undatable context, the other one in Austin component levels. The latter tool is assymetric, i.e., its sharp point does not lie exactly on the length axis of the tool. The edges of this tool have also been slightly blunted by small, steep secondary unifacial retouch.

3. <u>bifaces with a strongly convex base, thick cross-sction</u>: n = 1
   This biface is the smallest in its category. It was made on a flake, and a small part of its ventral face is still preserved. The biface has an intentionally blunted tip.

4. <u>subtriangular, elongated bifaces, thick cross-section</u>: n = 1
   This biface is triangular, elongated, and entirely bifacially retouched on all edges. The top is slightly blunted, and the base is slightly concave; its cross-section is relatively thick. The only other similar biface was found at site 41WM267.

B. Medium and large triangular or subtriangular bifaces

1. <u>large, subtriangular bifaces, with a strong convex base</u>: n = 1
   This tool is a very finely worked biface; the edges and the base are likewise very carefully retouched, finished by bifacial secondary retouch. The tip is very sharply pointed, and slightly curved. No traces of grounding or smoothing were observed on the tool edges.

A similar biface was found at stie 41WM57, although the two tools were dated in very different time zones.

2. triangular bifaces, with a strong concave base: n = 1
This tool is a medium large triangular biface, which was very carefully worked on both edges and the base. The edges are slightly convex, while the base is distinctly concave, and bifacially thinned. The tip of the biface is very sharp. This biface is a unique specimen, the only one recovered from either reservoir. (It has been suggested that this biface form is an unfinished projectile point, type Fairland.)

3. very elongated triangular bifaces: n = 1
This biface is a relatively thin, and very carefully worked tool, retouched along both edges and the base by secondary bifacial retouch. Its basic form is triangular, the largest width at the base, with both edges only slightly convex, and the base straight.

A similar tool was recovered from site 41WM56.

C. Bifaces, with accentuated, pointed working ends

1. finished tools: n = 1
This tool is similar to four found at site 41WM56 and one from site 41WM304, but it is slightly wider than any of those. The base is rather irregularly bifacially worked, and the slight narrowing towards the pointed end starts about halfway its length, and in several places, the bifacially retouched edges are somewhat denticulated.

D. Miscellaneous

1. small elongated bifacial tools. n = 1
This small biface was entirely secondary bifacially retouched. Its edges were parallel for almost their complete length, and taper towards a point only at the very distal part of the tool. The base is narrow, and slightly convex.

Two other similar bifaces were found, at site 41WM53 and 41WM168, but both are more quadrangular in shape and not pointed at one end.

E. Preforms

1. less intensively worked preforms
a. large ovoid preforms: n = 1
The only probably unfinished bifacial artiface recovered from this site is a crudely retouched tool; its edges are irregular, and both extremities are more or less secondary unifacially bevelled, on alternate faces of the biface. No cortex was preserved on the artifact.

F. Biface fragments

1. <u>basal fragments</u>
    a. basal fragments with a more or less straight base, edges at sharp angles with the base: n = 3
    Three fragments were recovered from this site. One is a small fragment, probably an unstemmed point fragment. The second is a very finely retouched fragment, badly damaged during recovery, with slightly concave base and edges, and sharply pointed base corners. The third fragment is a relatively large fragment, with no signs of tapering towards the fracture, i.e., its edges are parallel for the whole length of the fragment.

    b. basal fragments with a more or less straight base, edges at obtuse angles to the base: n = 1
    One such fragment was found which was made on a flake, with lamellar bifacial basal thinning

    c. basal fragments with a convex outline: n = 2 (1 burned)
    Both fragments are bifacailly retouched on both edges, and somewhat more unifacially worked on the base.

2. <u>top fragments</u>
    a. fragments that form an angle of 90^{0}
        1. small fragments: n = 1

        2. large fragments: n = 1

    b. biface fragments where the top makes an angle less than 90^{0}
        1. large fragments: n = 2
        One fragment was made on a flake.

    c. biface fragments where the top makes an angle greater than 90^{0}
        1. large fragments: n = 1

3. <u>medial fragments</u>
    a. narrow fragments, the maximum width less than 20 mm: n = 2 (burned)
    One relatively long fragment has a small squared shoulder, and is possibly a projectile point fragment.

    b. medium fragments, width more than or equal to 20 mm and equal to or less than 40 mm: n = 2 (burned)
    One fragment is very badly damaged by fire.

4. <u>edge fragments</u>: n = 4 (2 burned)
One fragment haa a little bit of cortex left on one face.

5. <u>unidentifiable fragments</u>: n = 1 (burned)

14-216

XIII. Axes

A. Bifacially worked axes with a straight bit: n = 1 (whole)

One very small, slightly damaged triangular biface was recovered from the Toyah levels of this site. The axe is rather thick, especially on one face, but all edges except the butt are intensively bifacially retouched. The butt is slightly damaged.

XIV. Chopping tools: n = 2 (whole)

Both tools were made on medium large angular pebbles by intensive retouch at one narrow end.

Site 41WM267

I. Scrapers

All scrapers from this site were recovered from areas A, B, and D, with the highest density in area B. No scrapers at all were recovered during excavations in area C.

A. Single endscrapers

1. single endscrapers on flake: n = 4 (2 whole, 1 burned)
   One single endscraper was made on a Sa flake by steep and regular dorsal retouch. The flake has a nearly perfect conical bulb. The three other tools were made on Sb flakes by steep to oblique, regular dorsal retouch. None of the tools has any other retouch.

2. single endscrapers on a retouched flake: n = 2 (whole)
   Both endscrapers were made on tertiary flakes by regular dorsal retouch. One tool is also retouched along both edges, the other endscraper was truncated on its proximal end. The truncation is deep concave, and made by intensive dorsal retouch.

3. denticulated endscrapers: n = 1 (whole)
   The only denticulated scraper in this assemblage is a roughly retouched endscraper on a Sb flake. The scraper bit itself is steeply dorsally retouched, the other edges are irregularly and non-continuously flaked. The ventral face is for the most part covered by large, flat ventral retouch.

B. Single sidescrapers

1. single sidescrapers on flake: n = 2 (1 whole)
   One complete and one fragmentary single sidescraper were both made on Sa flakes. The fragmentary specimen has a straight, steep scraper bit, made by very large dorsal retouch. The complete specimen has a regular, markedly concave scraper bit. This bit was made by steep, large retouch; a few small ventral retouch could be use-retouch.

2. single sidescrapers on a retouched flake: n = 2 (1 whole, 1 burned)
   One complete and one damaged (firecracked) single sidescraper were made on a Sa and a tertiary flake, respectively. Both tools have the scraper bit retouch mainly on their dorsal face, although both also have some ventral flaking.

The complete tool was made on a previously retouched and heavily (brown) patinated flake. The patino is even, covering the anterior retouch on the flake.

3. single inverse sidescraper: n = 2 (1 whole)
An inverse sidescraper was made by steep ventral retouch on the left edge. Two notches are on the same edge, one on each side of the scraper bit. The right edge of the tool is also retouched by oblique and large ventral retouch. This tool may also be called a "single sidescraper with notches."

C. Double scrapers

1. double endscrapers: n = 1 (whole)
Both ends of a Sb flake were worked into scraper bits by rather small, steep dorsal retouch. The retouch on the distal scraper bit is very small, the retouch on the proximal bit is medium sized. The scraper bits are not symmetrically placed on the length axis of the flake, although they are parallel.

2. double sidescrapers: n = 2 (1 whole)
A double sidescraper made on a tertiary flake was only partially preserved. But both its scraper bits were preserved, and they were made by very careful oblique dorsal retouch. The complete artifact was made on a Sb blade. Both extremities of the blade were flaked by large to very large dorsal retouch. The scraper bits are oblique with regard to the length axis of the blade.

3. single end and single sidescrapers: n = 2 (whole)
One of the single end and single sidescrapers found at this site was made on a Sa flake. The artifact has two slightly concave scraper bits, both made by large oblique dorsal retouch. On the other artifact, both scraper bits meet in a sharp angle at the right distal corner (also called "dejete"). One of the bits is only slightly convex, the other bit is strongly convex. Both were made by steep, large to very large dorsal retouch.

D. Multiple scrapers: n = 1 (whole)
A multiple scraper with three scraper bits was made on a Sb flake. All the working edges were flaked regularly by steep, generally large dorsal retouch. The proximal end of the flake is slightly pointed and retouched by covering oblique ventral retouch. Part of the right edge has fine oblique retouch, forming a small fourth inverse scraper bit.

E. Other scrapers

1. core scrapers: n = 3 (2 whole)
One core scraper fragment was preserved on the distal end of a plunging flake. It was made on a former core platform edge. The two complete specimens were made on irregular multi-platform cores, on which one of the core platforms was transformed into a scraper bit.

F. Scraper fragments: n = 5 (2 burned)
Two of the fragments are heavily fire cracked; one of these was made on a Sb flake fragment. All the other artifacts are tertiary fragments. One was preserved on the distal end of a plunging flake.

II. Denticulated Pieces

No denticulated pieces were excavated from area C. All artifacts recovered were found in area A, B and D, with the highest concentration in the latter.

A. Serrated pieces

1. one edge is entirely serrated: n = 6 (4 whole)
Three artifacts were made on tertiary flakes, and two on Sb flakes. The sixth artifact was made on a Sb microblade. The serration occurs in all tools over nearly a whole edge, and in all cases the fine denticulation was obtained by mixed ventral and dorsal retouch. One tool had two additional large notches on the distal extremity of the flake

2. one edge is partially serrated: n = 1 (whole)
One tertiary flake has very small, barely visible serration on the distal end on part of the left edge. As in the above cases, the serration was obtained by mixed dorsal and ventral retouch.

3. serrated fragments: n = 2
Both fragments are very small (16 mm) tertiary elements, finely serrated on part of their edges.

B. Denticulated pieces

1. denticulated flakes
a. denticulated only: n = 22 (13 whole)
Six denticulates were made on heavy primary and Sa flakes and eight on Sb flakes. All the other artifacts were made on tertiary elements. One of the tool fragments on a Sb element was possibly made on an

atypical blade. One of the primary flakes is a natural flake.
This denticulate assemblage is very heterogeneous. Some flakes have nearly a whole edge more or less regularly denticulated, others only on a small part. Some are denticulated on their distal extremities, and one on its proximal end. Most of the notches forming the denticulation are irregular in width as well as in depth.

b. with additional retouch: n = 1 (whole)
This artifact was made on a tertiary flake by regular dorsal retouch. The tool is denticulated along part of its right edge. Additional ventral retouch occurs along the left edge.

c. with ventral preparation: n = 2 (whole)
Two thick but small Sa flakes were denticulated after their ventral face was prepared by that retouch. One artifact was thus denticulated on its distal end; the other one along an edge. This latter tool had regular dorsal denticulation along the other edge also.

2. denticulated blades, bladelets and microblades: n = 2/whole)
A tertiary blade and a Sb blade were both denticulated by dorsal retouch along part of their right edge. The Sb blade is an irregular one, which was also irregularly retouched on the other edge and on the proximal end. This last tool was recovered in an undatable context (BHT).

3. other denticulated pieces: n = 1 (whole)
This artifact was possibly made on a core. The denticulated edge was intensively flaked by large to very large retouch, and has a distinct concave outline. This unique tool was found in San Geronimo dated levels.

C. Fragments: n = 5 (2 burned)
Two Sb and three tertiary fragments were parts of dorsally denticulated tools. One of the tertiary fragments was part of a bifacially denticulated tool.

III. Notched Pieces

A. Single notches on flakes

1. single notch only: n = 38 (11 whole, 3 burned)
Most notched pieces were made on tertiary flakes (24 or 63%); 10 were made on Sb flakes, and four on Sa flakes.

The notches on 18 artifacts were made by dorsal retouch, 20 by ventral retouch. Most of the notches are located on one of the edges, fewer on the distal end of the flake. Only one of the tools has a notch on its proximal extremity.

2. <u>single notch with additional continuous retouch</u>: n = 4 (1 whole)
Four tertiary flakes were notched by dorsal retouch on their left edge. The additional continuous retouch is regular retouch along the other edge, dorsal for three tools, ventral for the fourth one.

3. <u>large and crude notched tools</u>: n = 6 (3 whole)
Four heavy Sb flakes were notched by a steep or oblique large retouch, three by dorsal retouch and one by ventral retouch. One tool was made on a heavy tertiary flake with an intensively ventrally retouched notch in one edge; this artifact has some additional retouch on its distal end. The fragment is quite extensively recently damaged. Another tool was made on a large Sa flake by slightly curshed, small dorsal retouch.

B. Multiple notches on flakes

1. <u>non-adjacent notches</u>: n = 7 (4 whole)
Five artifacts were made on tertiary flakes and two on secondary a flakes. One artifact, made on a tertiary flake, has several notches, made by both ventral and dorsal retouch. The distal end of this flake was fractured concave, and from this fracture plane another notch was made by relatively few retouch. All the other tools except one have notches that were made by dorsal retouch. Nearly all the notches are located along the edges, very few on the distal end.

2. <u>occasionally adjacent notches</u>: n = 5 (1 whole, 2 burned)
Three artifacts were made on Sb flakes, two on tertiary flakes. Nearly all notches were made by dorsal retouch, only one artifact had notches which were ventrally flaked. Notches are located on both edges with one exception only, where the notches are on the distal end.

3. <u>two adjacent notches, alternating retouch</u>: n = 1
This artifact was made on a tertiary flake, on its left distal corner. One notch, the one on the distal end, was made by dorsal retouch, the other one by ventral retouch.

C. Notched blades, bladelets and microblades

1. single notch: n = 2 (1 whole)
A Sb blade and a tertiary blade have a single notch on one edge, made by dorsal retouch. The Sb blade also has regular ventral retouch on the other edge.

2. multiple notches: n = 1 (whole)
Two non-adjacent notches were made by dorsal retouch on the left edge of a Sa blade. The material is a coarse flint variety, which was slightly patinated before the notches were made.

D. Other notched pieces

1. meganotch: n = 3 (2 whole)
A tertiary flake, a tertiary blade and a Sb flake have a very large notch, made by small dorsal retouch. Two of the notches are on a distal angle of the flake, the third one in the middle of the left edge.

2. alternatingly retouched notches: n = 1 (whole)
In the medial part of each edge of this tertiary flake, there is a notch. The notch on the left edge is small, made by fine dorsal retouch. The other notch is made by equally fine ventral flaking. There is more retouch along both edges towards the proximal end of the flake.

E. Fragments: n = 7 (3 burned)
Six of the notched flake fragments are on tertiary elements. Five pieces have remnants of dorsally retouched notches, two have remnants of ventrally retouched notches. One fragment was on a Sb flake, and shows two adjacent dorsally retouched notches.

IV. Boring Tools

A. Gravers
All gravers recovered from site 41WM267 come from area A, B and D. None were found in area C.

1. gravers on the flake axis: n = 7 (5 whole, 1 burned)
Two sharply pointed gravers on the distal end of a Sb flake and a tertiary flake were formed by two straight edges with small but steep dorsal retouch. Another graver subtype is in reality very similar to the above gravers, but this subtype has a relatively heavy, triangular graver point.

Two such tools were made on Sb flakes by steep dorsal retouch. This is the only site where this graver subtype has been recovered; one specimen was found in San Marcos context, the other one in Clear Fork context. One graver was of the "beaked" variety, made by careful dorsal retouch on the distal axis of a Sb flake. Two other gravers were formed by a short straight edge and a notch. One was made by vental, the other by dorsal retouch.

2. gravers on the flake edge
   a. "beaked" gravers: n = 5 (4 whole)
      All these gravers were formed by two notches, usually by dorsal retouch. One artifact was made by ventral flaking, and one exceptional tool was made by bificial retouch. The notches that form the graver point are always deep and pronounced. Two of the artifacts were made on tertiary flakes, one on a Sb flake and one on a chunk. The one exceptional tool is a double graver, made on an exhausted core by small to medium regular retouch.

   b. "normal gravers: n = 4 (2 whole)
      Three of these artifacts were made by dorsal retouch on tertiary elements. The fourth artifact was made by ventral retouch on a Sb flake.

3. oblique gravers: n = 1 (whole)
   This normal oblique graver was made by dorsal retouch on the distal end of a tertiary flake.

4. graver fragments: n = 1
   One otherwise unidentifiable graver fragment was manufactured on a Sb flake fragment.

B. Borers
   Borers were recovered from area A and B only.

1. borers on the flake axis: n = 1 (whole)
   On the distal end of a tertiary flake this borer point was made by regular steep alternate retouch.

2. borers on the flake edge: n = 3 (whole)
   Two tools were made on Sb elements, one flake and one blade, and the third tool was made on a Sa flake. In all instances the borer point was located on the left edge, made by alternate retouch. The borer made on the edge of the Sb blade was recovered within feature 19.

3. oblique borers: n = 3 (2 whole)
   One oblique borer was made on a large tertiary flake by small dorsal retouch. The borer point is heavy and triangular in cross-section. Another oblique borer, made on a Sb flake is similar, and has a rather wide angled point. Both this last tool and the third one, also made on a Sb flake, were made on the distal part of the flake.

4. other
   a. on a flake spall: n = 1 (whole)
      This borer was made on the pointed part of a narrow flake spall by steep small retouch.

   b. on burin spall: n = 1 (whole)
      This borer was manufactured on a secondary burin spall of a rather unusual pale brown flint variety. The triangular point was bifacially retouched on the former tool edge, and was additionally retouched by small flat retouch on the ventral face of the burin spall.

C. Drills

1. on point base: n = 1 (whole)
   This drill is a very fine, complete specimen made on a shouldered point base.

2. on non-point base: n = 2 (whole)
   The tool, from a backhoe trench, has a small basically triangular base with completely covering bifacial retouch. The other has a wide rectangular base, also with completely covering bifacial retouch.

3. fragments: n = 1 (burned)
   This tool is a long drill bit fragment.

V. Truncated Pieces

A. Single distal truncations

1. dorsal retouch: n = 12 (10 whole)
   Two truncations were made on Sb flakes, eight others were made on tertiary flakes. All these truncations are straight to slightly convex, made by steep, small to medium retouch. Two truncations are also oblique. An eleventh truncation was made on a Sb blade by steep, perpendicular retouch. This truncation is slightly concave. Close to the proximal end are two large, shallow notches, one on each edge. The one on the left edge was made by dorsal retouch, the one on the right edge by ventral retouch. The last tool was

made on a Sb core trimming flake. The artifact was truncated by perpendicular medium to large retouch, and also has some additional flat ventral retouch on the proximal extremity.

2. ventral retouch: n = 2 (1 whole)
Both truncations were made on ventral retouch on the distal end of small tertiary flakes.

B. Single proximal truncations

1. dorsal retouch: n = 5 (4 whole)
Four truncations were made on tertiary flakes by very steep, small dorsal retouch. One artifact was snapped, and then retouched from the fracture plane. One of the truncations occurs as a small notch, or as an oblique concave truncation. The fifth tool was made on a Sa flake. The straight truncation was flaked by perpendicular small to medium retouch.

2. ventral retouch: n = 2 (whole)
A straight ventral truncation was made on the proximal end of a primary flake. The second artifact was made on a tertiary flake.

VI. Backed Pieces

Backed pieces were almost exclusively found in area D. Only two artifacts came from area A.

A. A whole edge is backed

1. straight or slightly convex edge

a. dorsal retouch: n = 1
The tertiary flake fragment was backed along the right edge by small steep retouch.

b. ventral retouch: n = 1 (whole)
This tertiary flake was also backed along its right edge by small oblique retouch.

2. convex edge: n = 2 (, whole)
One tool was made by perpendicular retouch on the right edge of a tertiary flake. The other tool was made by steep retouch, on the right edge of a Sb flake. Both artifacts are dorsally retouched.

3. concave edge: n = 3 (1 whole)
   A tertiary flake and a Sa flake were backed on their left edges by steep, small to medium retouch. A Sb flake fragment was backed on the left edge by steep, large to very large retouch. This tool also has some regular steep bifacial retouch on its left edge. All the above tools were made by dorsal retouch.

B. Partially backed edge

1. dorsal retouch: n = 3 (1 whole)
   Two tertiary flakes were partially backed along their right edge by small, steep retouch. On both tools the backed edge is straight. A fragment of a small Sb flake was partially backed on one edge, while the other edge is cortex backed.

2. partially backed blades, bladelets and microblades: n = 1
   A tertiary (micro) blade fragment was partially backed by ventral retouch on its right edge. The backed edge is straight.

C. Double backed pieces

1. both edges are straight to slightly convex: n = 3 (1 whole)
   A tertiary and a Sa flake fragment were both double backed by steep, somewhat irregular dorsal retouch. The third artifact is a Sb blade also backed along both edges by steep, medium to large dorsal retouch. The backing is partially denticulated.

D. Fragments: n = 3 (1 burned)
   All three fragments are parts of backed pieces which could not be classified in any of the above types. All are tertiary elements.

VII. Burins

A. Single angle burins

1. on snap: n = 11 (9 whole)
   Four of the single angle burins on snap were made on flakes, three on Sb flakes, one on a Sa flake. Two of the flakes have some other rather irregular retouch. The other two flakes were not retouched at all. Seven other burins were made on bifacial tool fragments (i.e., three projectile point fragments, and four biface fragments). Only a few burins were made by multiple burin blows. Two tools were resharpened.

2. <u>on truncation</u>: n = 1 (whole)
   A single angle burin was made on a concave truncation on the distal end of a tertiary flake. The truncation was made on steep, small dorsal retouch.

3. <u>other</u>: n = 2 (whole)
   Two burins are single angle burins from the flake platform. One platform is single facetted, the other one is a cortex platform. The former tool was also retouched along one edge.

B. Double angle burins

1. <u>on one extremity, opposed edges</u>: n = 3 (2 whole)
   Two of these double angle burins were made on fractured point fragments, the third artifact was made on a biface fragment. All tools are single facetted burins. One artifact is damaged on one of its burin bits.

2. <u>on opposed extremities, opposed edges</u>: n = 1 (whole)
   A double angle burin was made on a tertiary flake. One of its bits was multifacetted, the other one single facetted. There was possibly a third burin bit on this flake, but that part of the artifact was damaged.

C. Dihedral burins

1. <u>dihedral burins on angle</u>: n = 3 (whole)
   Three dihedral angle burins were made on Sb flakes, one of which was also retouched continuously along one edge. The retouch was medium, oblique and regular.

2. <u>dihedral burins on axis</u>: n = 1 (whole)
   This dihedral burin was made on the length axis of a large, roughly retouched biface fragment. One of the burin facets is very short. The other extremity of the tool is damaged by a recent scar (made by a metal object), which resembles a burin facet.

D. Transversal burins

1. <u>single transversal burins</u>: n = 2 (whole, 1 burned)
   Two transversal burins were made on flakes, one Sb flake and one tertiary flake. Both were spalled from lateral snaps. One of the artifacts has a very narrow burin bit, and was obliquely retouched by medium to large, dorsal retouch along one edge.

E. Oblique burins: n = 5 (4 whole, 1 burned)
Three single oblique burins were made on Sb flakes. One artifact was made obliquely on the proximal end of the flake by two burin spalls. One other burin was a carinated burin, made by multiple burin spalls. The third tool was single facetted. The carinated burin is fire-damaged. Two other single oblique burins were made on otherwise complete projectile points. One artifact has only one facet, the other one has been renewed. It is possible that either artifact was obtained accidentally on point impact.

F. Multiple burins: n = 1 (whole)
This multiple burin has two dihedral burins on angle and one angle burin on snap. The burins are single facetted as well as multiple facetted. The artifact was made on a Sb flake.

VIII. Composite Tools: n = 1 (whole)

This tool, a burin-graver combination, was made on a Sb flake. The burin is a single transversal burin on the distal end, from an unretouched right edge. The graver is also made on the right edge, by ventral retouch on the proximal half of the edge.

IX. Retouched Pieces

A. Pieces with unilateral retouch

1. dorsal retouch
a. retouched edge
1) nearly entire edge: n = 70 (30 whole, 14 burned)
The complete tools were

made on		ret. left edge	right edge
tertiary flake	13	5	8
tertiary microblade	2	2	-
tertiary microflake	2	2	-
Sb flake	11	5	6
Sb blade	1	1	-
Sa flake	1	1	-
		16	14

The retouch on almost all pieces is oblique to steep and small, while the retouched edge is usually more or less straight or convex. Two artifacts have a partially concave retouched edge.

The fragments were

made on		ret left edge	right edge
tertiary flake	27	13	14
tertiary blade	2	2	-
tertiary chip	3	2	1
Sb flake	6	3	3
Sa flake	2	1	1
		21	19

Most of the fragments are very similar to the whole retouched pieces discussed above. One large tertiary fragment is possibly a scraper fragment.

2) less than half the edge: n = 27 (12 whole, 1 burned)
The complete tools were

made on		ret. left edge	right edge
tertiary flake	6	3	3
tertiary blade	1	1	-
tertiary micro-flake	1	-	1
Sb flake	3	2	1
Sa flake	1	1	-
		7	5

The Sa flake, the tertiary blade and one tertiary flake were all flaked on the proximal half on the edge by small, oblique marginal retouch. The secondary b flakes, the tertiary microflake, and two tertiary flakes were all retouched on the distal part of the edge. The other artifacts were medially retouched. The tertiary blade has recently been damaged. The fragments were

made on		ret. left edge	right edge
tertiary flake	7	4	3
Sb flake	6	2	4
Sa flake	2	1	1
		7	8

Seven fragments were proximally retarded, three medially. The other fragments were retouched on the distal part of the edge.

b. retouched end

1) distal end: n = 44 (31 whole, 4 burned)

The tools were

made on		whole	fragments
tertiary flake	19	13	6
tertiary bladelet	1	1	-
Sb flake	20	15	5
Sa flake	2	1	1
primary flake	2	1	1
		31	13

Most of the artifacts are flaked by small oblique dorsal retouch on the entire or part of the distal end. Three tools are possibly truncation fragments, but only partially preserved. Their retouch is somewhat larger and deeper than for the other artifacts in this category.

2. ventral retouch

a. retouched edge

1) nearly entire edge: n = 58 (28 whole, 8 burned)

The complete tools are

made on:		ret. left edge	right edge
tertiary flake	15	5	10
tertiary microblade	1	1	-
Sb flake	7	4	3
Sb microflake	1	1	-
Sa flake	4	2	2
		13	15

The tools are more or less continuously regularly flaked along most of an edge, almost exclusively by small, oblique to steep retouch. One of the tertiary flakes is a very small bifacial thinning flake, retouched ventrally along its edge.

The fragments are

made on		ret. left edge	right edge
tertiary flake	16	9	7
Sb flake	9	3	6
Sa flake	3	3	-
chips	2	2	-
		17	13

2) less than half an edge: n = 32 (21 whole, 1 burned)
The complete tools are

made on		ret. left edge	right edge
tertiary flake	7	2	5
tertiary blade	1	1	-
tertiary bladelet	1	1	-
Sb flake	3	1	2
Sb blade	1	1	-
Sa flake	6	4	2
		10	9

Most of these retouched pieces are retouched in the middle of one edge. The others are flaked either on the proximal or on the distal part of one edge.
The fragments are

made on		ret. left edge	right edge
tertiary flake	8	5	3
Sb flake	4	3	1
		8	4

Most of these fragmentary pieces are retouched in a way very similar to the complete pieces discussed above. Only one secondary b flake is an exception. The flake is an angular one with large flat retouch on the proximal part of one edge.

b. retouched end

1) proximal end: n = 2 (1 whole, 1 burned)
The platform and part of the bulb of a Sb flake were removed by large irregular flat/oblique retouch.
A small tertiary chip was also proximally retouched.

2) distal end: n = 9 (5 whole, 1 burned)
The tools are

made on		whole	fragments
tertiary flake	2	1	1
tertiary microflake	1	1	-
Sb flake	4	2	2
primary flake	1	-	1
chip	1	-	1
		4	5

The tertiary flake fragment was steeply retouched by medium large retouch, and may be a fragment of a truncation. The tool made on the primary flake was flaked by very large and irregular ventral retouch.

3. bifacial retouch
   a. retouched edge
      1) nearly entire edge: n = 5 (3 whole)
         The complete tools are

made on		ret. left edge	right edge
Sb flake	1	1	-
Sa flake	1	-	1
Sa blade	1	-	1
		1	2

The bifacial retouch is somewhat irregular on both whole flakes. The blade on the contrary, is very regularly retouched, flat to oblique on the dorsal face, and flat medium to large ventral retouch. This retouch covers the entire edge, and also removed part of the bulb. Both incomplete tools are irregularly bifacially retouched tertiary flake fragments.

      2) less than half an edge: n = 1
         Part of the left edge of a Sb flake was regularly flaked. The retouch is large and oblique. The tool fragment is heavily damaged.

   b. retouched end
      1) distal end: n = 1 (whole, burned)
         This tool was made on a Sa flake, irregularly bifacially retouched, but mostly on the dorsal face. In places, the retouch is slightly crushed.

4. alternating retouch
   a. retouched edge: n = 10 (5 whole, 2 burned)
      The whole tools are

made on		ret. left edge	right edge
tertiary flake	3	1	2
Sb flake	1	-	1
Sb blade	1	-	1
		1	4

All the above tools were made by fine to small oblique retouch. The Sb blade was naturally (cortex) backed on its left edge.
The fragments are

made on	ret.	left edge	right edge
tertiary flake	2	1	1
Sb flake	3	1	2
		2	3

The retouch on one of the Sb flakes is larger than on all the other tools in this subtype. In most cases, the retouch is fine to small.

5. <u>other retouch - mixed bifacially and unifacially</u>
   a. retouched edge: n = 3 (whole)
      All these retouched pieces were made on Sb flakes, one was retouched on the left edge, the other two on the right edge. The retouch is small to medium. One of the flakes was recently damaged.

6. <u>discontinuous retouch</u>
   a. retouched edge: n = 10 (6 whole)
      The whole tools are

made on	ret.	left edge	right edge
tertiary flake	1	-	1
Sb flake	2	2	-
Sa flake	3	2	1
		4	2

The fragments are

made on	ret.	left edge	right edge
tertiary flake	1	-	1
Sb flake	1	-	1
Sa flake	2	1	1
		1	3

Two fragments have very similar, irregular slightly scaled retouch which is not very intensive. One of the Sa flakes also has a light but extensive use-polish on the ventral face along the discontinuously retouched edge.

B. Pieces with bilateral retouch

1. <u>Dorsal retouch</u>
   a. two retouched edges
      1) nearly entirely retouched edges: n = 9
         All these tools are fragments, two of which were made on a Sb flake, six others on tertiary fragments. One artifact was made on a chip size tertiary element. The retouch on all these tools varies considerably, ranging from smahl steep retouch to medium, to large oblique retouch, with a few tools which were steeply retouched.

      2) one nearly entire edge and one partially: n = 1 (burned)
         A Sb flake fragment was retouched along the entire length of its left edge, as well as on a small part proximal on the right edge.

      3) both edges partially in equivalent loci: n = 4 (3 whole)
         Two tertiary flakes, a Sb flake and a Sa flake fragment were all partially retouched on their edges by large, medium and small retouch.

      4) both edges partially in un-equivalent loci: n = 2 (1 whole)
         The complete tool was made on a tertiary flake, which was retouched near the proximal and near the distal end. The fragmentary tool was made on a heavy Sa flake. The retouch is large steep normal retouch along one edge, and is partially patinated, scaled retouch on the other edge.

   b. one end and one edge retouched
      1) both nearly entirely retouched: n = 4 (2 whole)
         Three tertiary flakes and one Sb bladelet were worked by steep to oblique small retouch. The distal end of the bladelet is very narrow and irregularly pointed.

      2) both partially retouched: n = 4 (whole)
         These tools were made on three Sb flakes and one tertiary flake. The flaking is usually a fine to small retouch on part of the distal end and part of the right edge of the flake.

2. ventral retouch
   a. two retouched edges
      1) nearly entirely retouched edges: n = 1
         A small tertiary flake fragment was retouched by small oblique retouch.

      2) one nearly entire edge and one partially: n = 1 (whole)
         A tertiary flake was retouched regularly over its whole left edge and a small part proximal near the right edge. This is the only specimen in this subtype recovered in both reservoirs.

      3) both edges retouched partially, equivalent loci: n = 1 (whole)
         A Sb flake was partially retouched proximal on both edges by regular small oblique retouch.

      4) both edges partially, unequivalent loci: n = 2 (whole)
         A Sb and a tertiary flake were retouched proximal on one edge, medial on the other one. The retouch is regular, small and oblique.

   b. one end and one edge retouched
      1) both nearly entirely retouched: n = 2 (1 whole)
         Heavy Sa and Sb flakes had their platform and part of their bulb removed by medium to large oblique retouch. Both had also some more retouch on one of their edges.

      2) both ends retouched: n = 1
         This artifact was made on a partially patinated Sa flake by large to very large oblique retouch.

3. alternating retouch
   a. two edges, one retouched alternatingly: n = 5 (3 whole)
      These tools were

made on	whole	fragments
tertiary flake	-	2
Sb flake	2	-
Sb blade	1	-
	3	2

All tools were made by small oblique retouch. The blade was only partially retouched on the left edge by ventral flaking.

b. one edge alternatingly, and one end retouched: n = 1 (whole)
This tool was made on a tertiary flake by small oblique retouch.

4. alternate retouch
a. two edges
1) two nearly entirely retouched edges: n = 8 (1 whole, 1 burned)
These tools were

made on		whole	fragments
tertiary flake	4	-	4
Sb flake	3	1	2
chip	1	-	1
		1	7

All except one of the above tools was made by small, oblique to steep retouch. The one exception was flaked by large retouch. One tool has been damaged by recent retouch.

2) one edge whole, one partially retouched: n = 2 (whole)
Both tools were made on tertiary elements, one flake and one blade. They were retouched partially on the left edge.

3) both edges partially retouched, equivalent loci: n = 7 (5 whole)
These tools were

made on		whole	fragments
tertiary flake	2	1	1
tertiary microblade	1	1	-
Sb flake	2	1	1
Sb blade	1	1	-
Sa flake	1	1	-
		5	2

There is no distinct patterning in the location of the retouch on the tool edges. Retouch is distal as well as medial and proximal.

4) both edges partially retouched, unequivalent loci: n = 3 (2 whole)
The complete tools were made on a tertiary and a Sb flake; the fragment was also a Sb element. All pieces were made by small oblique regular retouch.

5) Crude retouch: n = 1 (whole)
A large and heavy Sb flake was irregularly retouched along both edges. This retouch varies from small to very large; most of the latter occur at the distal end of the flake.

b. one edge and one end: n = 6 (whole)
These tools were made on three tertiary flakes, two Sb flakes and one Sa flake. All were made by small oblique retouch. Sometimes the whole edge of the flake will be retouched, sometimes only a small part.

5. <u>other</u>
a. mixed bifacial and unifacial retouch
1) two retouched edges: n = 1 (whole)
This tool was made on a heavy primary flake, made partially by bifacial retouch.

b. discontinuous retouch
1) two edges: n = 7 (3 whole)
These tools were

made on		whole	fragments
tertiary flake	3	1	2
Sb flake	2	1	1
Sb blade	2	1	1
		3	4

All tools had irregular small and discontinuous retouch along most of both edges. One tertiary tool was made on a chalcedomy flake.

2) one edge and one end: n = 1
One tertiary fragment was discontinuously retouched on its distal end and left edge.

C. Pieces with multilateral retouch

1. <u>bifacial retouch</u>: n = 1 (whole, burned)
This tool was made by intensive marginal bifacial retouch on all edges except the proximal end. This retouch is large to very large and oblique. The artifact is patinated.

2. <u>mixed bifacial and unifacial retouch</u>
a. two edges and one end
1) one edge bifacial: n = 5 (3 whole)

These tools were

made on		whole	fragments
tertiary flake	1	-	1
Sb flake	3	2	1
Sa flake	1	1	-
		3	2

All the retouch on these tools is large and usually very irregular.

3. mixed unifacial retouch: n = 7 (5 whole, 1 burned)
   These tools are

made on		whole	fragments
tertiary flake	5	3	2
Sb flake	2	2	-
		5	2

   These tools were made by small oblique retouch. A large Sb flake was partially ventrally flaked by large flat retouch, while elsewhere on the flake the retouch is medium sized oblique.

4. discontinuous retouch: n = 2 (whole)
   One tool was made on a Sb flake, the other on a tertiary flake.

D. Special retouched pieces

1. pointed flakes and blades: n = 2 (1 whole, 1 burned)
   One tool was made on a tertiary bladelet by fine and small dorsal retouch. The other tool fragment was made on a tertiary flake by small dorsal retouch which extends over most of the left edge.

2. pieces with a triangular cross-section: n = 1
   A midsection fragment of a tertiary blade was steeply dorsally flaked by medium to large retouch. Also, some retouch was detached from the dorsal rib towards the right edge.

3. Tool parts on "éclats outrepassés" (or "plunging" flakes): n = 3 (1 whole)
   Two tools are Sb elements, one is a tertiary flake. The latter piece is part of a further unidentified tool. One of the former possibly removed part of a core-edge, the other one could be a backed piece fragment.

E. Unidentifiable fragments: n = 103 (30 burned)

These fragments were made on:

- tertiary flakes	60	- primary flakes	1
- Sb flakes	28	- natural flakes	1
- Sb bladelets	1	- chips	7
- Sa flakes	3	- chunks	2

X. Bifaces

A. Small bifaces, triangular and subtriangular

1. <u>with a concave base, thin in cross-section</u>: n = 1
This artifact is slightly damaged at the top and one basal corner. The remainder of the artifact edges are regularly bifacially retouched. The base is slightly concave and bifacially thinned. Both edges are slightly convex. This artifact was found in Twin Sisters context, a date which is the same as for the other two bifaces in this subtype. (cf. sites 41WM124 and 41WM258)

2. <u>with a straight or slightly convex base, thick cross-section: n = 2 (1 burned)</u>
Two small, relatively thick, triangular bifaces with a slightly convex base were recovered from this site. One is dated in the San Marcos phase, the other one in the Clear Fork phase. The former tool is less carefully retouched than the latter and retains some cortex on one face.

3. <u>with a straight or slightly convex base, thin cross-section: n = 1</u>
This artifact is slightly damaged at the base, which was slightly convex. Both edges and the sharp point are carefully bifacially retouched. The point is a little accentuated by a slight narrowing of the edges.

4. <u>with a strongly convex base, thick in cross-section:</u> n = 2
One of the two small subtriangular bifaces with convex base was found in the Twin Sisters component. The other tool comes from a backhoe trench. The latter is well worked, with fine oblique secondary unifacial retouch on the base and one basal corner.

5. <u>with a strongly convex base, thin in cross-section</u>: n = 2
A thin triangular biface from this site, recovered from a backhoe trench, was secondary bifacially retouched on both edges, secondary unifacial by small oblique retouch on the same face, on the base, and the narrow straight tip.

The other artifact was found in a San Marcos context. There are no basal corners on this tool, and the base evolves smoothly from the edges.

6. subtriangular elongated biface, thick in cross-section: n = 1 (burned)
   This artifact was recovered from a backhoe trench. Both edges of the tool are convex, but assymmetric, both were made by secondary retouch, one bifacial, the other unifacial. The base of the artifact is not retouched, and the tip is partially burned. A comparable tool was recovered from site 41WM258. (cfr.

7. cruder larger artifacts with a strongly convex base: n = 1
   This tool was collected from the surface and is deeply patinated and severely damaged by plow scars. Part of the irregularity of the artifact is due to the recent damage.

B. Medium to large bifaces

1. irregular subtriangular bifaces: n = 2
   The two irregularly retouched triangular bifaces were both recovered from undatable context. Both are fairly regularly worked by secondary bifacial retouch. Neither one has basal thinning, one is pointed, sharp, the other's point is damaged.

2. irregular elongated subtriangular bifaces: n = 1
   A roughly bifacially retouched elongated biface, context unknown, was recovered from the site. One edge only is carefully retouched; the other one is only partially worked. On both extremities, some cortex is preserved.

3. elongated triangular bifaces, medium length: n = 2
   Of two very long bifaces, one is dated in the Clear Fork phase. In contrast to similar tools found at site 41WM56, these are carefully retouched bifaces, sharply pointed at one end. One of the two has a regular straight base, the other tool is also tapering at the basal end, although not as sharply pointed as at the other end. These two tools resemble the one found at site 41WM163.

4. triangular bifaces: n = 2
   Both tools are large and elongated regularly bifacially retouched. Both are sharply pointed and have a straight base. One tool was found in Clear Fork context, the other one in the San Geronimo levels of the site. It is possible that part of the base of the latter tool is missing. Only at site 41WM57 were similar artifacts present, but two are younger

(in the San Marcos/Clear Fork transition). One is also from a Clear Fork context.

5. "teardrop" biface (biface en larme): n = 1
A medium-sized biface, of a somewhat typical teardrop form, was recovered from a backhoe trench. The tool is very finely bifacially retouched, and sharply pointed. The point is also a little bit twisted.

6. wide subtriangular bifaces, with convex edges: n = 1
This artifact, which was found in an undatable context, has wide convex edges, which taper sharply to form a pointed end. The base remains unretouched and still has cortex.

7. unnamed bifaces: n = 2
Two bifaces, one undated and one from San Marcos levels, are similar to one tool found at site 41WM57. The largest tool is sharply pointed and has edges that are very carefully secondary bifacially retouched. In contrast to that, the base has almost no retouch at all. The second tool has a carefully retouched base, marked by a slight narrowing from the edges, thus creating the impression of a stem. This "stem" is carefully bifacially retouched over most of its contour, as is the rest of the tool. The tool has a markedly assymetric biconvex cross-section.

8. irregular subtriangular bifaces with a convex base: n = 3
These artifacts are similar to the above one tool, found in an undatable context, both others could be dated as from the San Geronimo period. The tools are all more or less irregularly bifacially retouched with a rounded point. Two tools are markedly plano-convex in cross-section.

9. irregular triangular bifaces with a straight base: n = 5
Related to the ones mentioned above are five triangular tools, with straight or light convex base. Four were dated in the Clear Fork period; the fifth is undatable. All retouch is secondary bifacial and completely covering. All tools are pointed, two sharply. Three tools have one edge secondary bifacially retouched, the other one unifacially secondary. One base still has its original surface, for all other tools the base is partially bifacially retouched. This biface subtype was represented at this site only.

C. Bifaces with an accentuated pointed working end

1. finished tools: n = 1
This tool is very sharply pointed at the distal end. The point and part of the edges are covered by very regular bifacial retouch. The retouch becomes more irregular towards the base and a small part of the base is still covered with cortex. The tool was found in Clear Fork context, and fits in with the other dated tools in this subtype.

2. unfinished tools: n = 3
Three pointed tools on an unfinished or irregularly worked base were recovered from this site, but only one could be dated, in the Clear Fork focus. All three are similar to the tool recovered from site 41WM304, and have a fine retouched sharp point and roughly worked bases, unworked in places.

D. Stemmed, notched and shouldered bifaces

1. stemmed bifaces, slightly recurving: n = 1
This stemmed biface is the only complete specimen of this category recovered from this site, although the biface was severely damaged. The tool broke in the middle, and a large part of one edge is damaged. The stemmed basal part of this tool is made by finely retouched converging edges and a very narrow base, also finely retouched on both faces. The stem is better worked than the rest of the tool, while the pointed end is not completely finished. A similar basal fragment was found at site 41WM56, also in Clear Fork context (cfr.

2. unnamed stemmed biface: n = 2
Two other stemmed pointed bifaces were recovered from the Clear Fork levels of this site. They differ from the ones mentioned above by the less fine bifacial work on the stem, and in one case the base is still cortex. Both also have a better worked and sharper point. The base is also not so clearly stemmed as well as just a distinct narrowing of the base. A similar artifact is present in the San Geronimo component of site 41WM56.

3. strangulated stemmed biface: n = 1
A unique triangulated biface was also found in the Clear Fork levels of the site. This tool is pointed and finely bifacially retouched, with two notches, one on each edge, just under midlength. Both notches are made by multiple bifacial retouch.

4. <u>shouldered bifaces</u>: n = 1
One assymetrical biface was recovered from a backhoe trench. The biface was made on an older, patinated tool, reworked all around by bifacial retouch, and part of the older patinated tool surface is visible in the middle of both faces. The tool is finely retouched and sharply pointed. A comparable tool was found on site 41WM57.

5. <u>double stemmed bifaces</u>: n = 1
This unique artifact was found in a Clear Fork context. It has very regularly bifacially retouch on all edges with very slightly convex edges. The oddity of this artifact is that it is stemmed on both ends. These stems are made like the single stemmed subtype 1. We have so far not found a parallel in the literature for this biface.

E. Miscellaneous bifaces

1. <u>chisels</u>: n = 1
An entirely bifacially retouched tool was called a chisel. It has a long, probably more or less pointed end, as a drill, but much wider. The chisel working end is a straight edge, sharpened by secondary oblique unifacial retouch. We think it is possible that the so-called stemmed bifaces, subtypes 1 and 5, are also chisels. But the above tool is a unique artifact; no comparable ones were found in either reservoir.

2. <u>bifaces with two sharp straight extremities</u>: n = 1
One entirely bifacially worked tool was recovered from Clear Fork levels. The tool is a very elongated oval, with probably two working edges, are regular, strongly convex extremity, carefully and symmetrical bifacially retouched. The profile of this working edge is also symmetrical. The other extremity has a very narrow, straight but sharp cutting edge, with an assymmetrical profile almost planoconvex, although bifacially retouched.

3. <u>subrectangular bifaces</u>: n = 1
This tool is an elongated rectangular biface, roughly bifacially retouched. Cortex is preserved on one face, and the tool is deeply patinated. A similar tool was found at site 41WM57.

F. Preforms

1. <u>intensively worked preforms</u>
a. small suboval or subcircular bifaces: n = 2

One tool is subcircular, slightly pointed at one end and regularly bifacially retouched on all edges. This tool is relatively thin. The other tool is suboval and irregularly bifacially retouched. The retouch is slightly crushed along both edges. This tool is relatively thick. This last tool was found in San Marcos context.

b. medium suboval or subcircular bifaces: n = 2
Both are irregularly retouched suboval artifacts, one of which is deeply patinated. This last tool was found in the San Marcos component.

c. This artifact is more or less regularly bifacially retouched with a strongly convex base and edges. The tool was deeply patinated and subsequently retouched along half of one edge by unifacial retouch.

d. medium sized, without a pointed extremity: n = 1
This artifact is a regular oval tool, bifacially retouched on all edges. Cortex remains on both surfaces.

e. medium sized, elongated preforms, without a pointed extremity: n = 2
One artifact is suboval, the other one subtriangular, both tapering to a sharp point. Both are relatively thick, but more or less regularly bifacially retouched.

f. miscellaneous: n = 1
This artifact is a regular slightly pointed oval tool made by regular bifacial retouch along its edges, more irregular on its base. The biface is also relatively thick and some cortex is present.

2. <u>less intensively worked preforms</u>

a. medium sized and large preforms, one extremity slightly pointed: n = 2
One artifact is regularly retouched along the edges, but irregular on the base. The other tool is irregularly retouched on all edges. The first artifact, recovered in a Clear Fork context, is patinated.

b. rectangular preforms: n = 1
This artifact was made by irregular bifacial retouch on three edges; the fourth edge was made by secondary unifacial retouch. All edges are slightly convex.

c. large ovoid preforms: n = 7
Most of these preforms are only partially bifacially retouched, usually along the edges. The extremities are left unretouched and contain cortex, or are secondary unifacially retouched.

3. preforms with minimal retouch
   a. crude randomly worked artifacts: n = 5
   Four artifacts have large amounts of cortex on at least one face. The fifth tool is patinated and very roughly retouched. This tool is possibly made on an exhausted core.

G. Biface fragments

1. basal fragments
   a. basal fragments with a more or less straight base, the edges at right angles with the base: n = 6 (1 burned)
   Six fragments were found. One carefully worked although relatively thick fragment is made of a coarse flint. A second fragment is heavily patinated. This last tool and the three others are very similar, with carefully bifacially retouched base and edges.

   b. basal fragments with a more or less straight base, the edges at sharp angles to the base: n = 5
   One nearly complete and four fragments were found, all medium sized to large. One fragment is irregularly retouched on the edges. All others are finely bifacially retouched. One fragment is a long fragment slightly tapered towards the fracture.

   c. basal fragments with a more or less straight base, the edges at obtuse angles to the base: n = 21 (6 burned)
   There are 21 such fragments, two of which are roughly bifacially retouched large fragments, five others are finely retouched equally large fragments. Interestingly, most of these large fragments were made of the same pale brown-grey flint. There are three small fragments, one possibly a point stem fragment; all the others are medium-sized. Five fragments are burned, three intensively. Seven flakes retained some cortex, mostly on the base. Except for the cortex on some fragments, all are retouched completely.

   d. basal fragments with a more or less straight base, the edges at mixed angles to the base: n = 3
   One fragment is bifacially retouched along its edge, its

base partially unworked. The second fragment is strongly serrated along its edges. The third fragment is retouched perpendicular from a snap.

e. basal fragments with a convex base: n = 25
Nine of 25 fragments still have cortex on at least one face, some a large amount. Most fragments are medium to large, have bifacially worked edges and usually also a bifacially retouched base. Two fragments have a secondary unifacially retouched edge. One of these occurs on the basal edge by oblique lamellor flaking, possibly a scraper bit.

f. basal fragments with a concave base: n = 1
This fragment is a carefully bifacially retouched artifact with a deeply concave base.

g. pointed basal fragments: n = 1
This fragment is irregularly bifacially retouched along one edge, regularly bifacially on the other.

h. shouldered and stemmed fragments: n = 1
One fragment found within the San Marcos component, has a short stem formed by a slight narrowing of the edges. The stem has a continuous strongly convex base.

i. special basal fragments: n = 1
This fragment has a straight oblique base, bifacially retouched and a small notch near one of the basal corners. The tool is patinated.

j. unfinished basal fragments: n = 10 (1 burned)
Four are very crudely bifacially retouched fragments; all retaining cortex. One fragment was made on a Sb flake. The two last fragments are finely retouched, except for a base, which is completely covered with cortex. One fragment was made on an older patinated biface or core.

2. <u>top fragments</u>
   a. fragments where the point forms an angle of 90^{o}
      1) large fragments: n = 6 (2 burned)
         The largest fragment is very roughly retouched, and was made on a deeply patinated former tool or core.

   b. biface top fragments with an angle less than 90^{o}
      1) small fragments: n = 13 (3 burned)

2) large fragments: n = 62 (3 burned)
One fragment is extremely finely serrated on one edge only by secondary oblique mainly unificial retouch. If the other edge was equally serrated, no trace of that is left. All beveled fragments are so only on a small part of one edge, always done by secondary unifacial retouch. The bevel is never steep. The retouch varies from very fine bifacial retouch to irregular bifacial retouch. One artifact was made of a very fine semitranslucent flint.

c. fragments where the top forms an angle of more than 90^{0}
1) large fragments: n = 6
One fragment was made on a flake, retouch covering on the dorsal face only.

3. <u>medial fragments</u>
a. narrow fragments, the maximum width is less than 20 mm: n = 7 (4 burned)
One fragment is totally patinated.

b. medium fragments, the maximum width is equal to or more than 20 mm and less than or equal to 40 mm: n = 23 (6 burned)
A finely retouched biface fragment has a plano-convex cross-section. Another fragment was serrated on both edges, made by fine bifacial retouch.

c. large fragments, the maximum width is more than 40 mm: n = 9 (1 burned)
One fragment is bevelled on one edge.

4. <u>edge fragments</u>: n = 51 (18 burned)
There are several fragments of unfinished tools, but only two that retain a small amount of cortex.

5. <u>unidentifiable fragments</u>: n = 2 (1 burned)

XII. Gouges: n = 4 (3 whole)

Four so-called "Clear Fork" gouges were recovered from this site, 3 intact, one lacking the butt. All have the characteristic assymmetrical biconvex cross section, i.e. an almost flat underside, and strong convex upper face, with a faint medial rib. The butt, where preserved, is tapering to an obtuse point; the working bit is in all cases slightly convex, and steeply secondary unifacially flaked from the flat underside. After microscopic examination under a low magnification (x10 - x15), extensive traces of wear were found on the butt part, on one face for one tool, on both for another. All tools were smoothed on their edges on the butt part

of the gouge, and all on at least one edge near the bit. These tools also show some wear on the bit itself.

XIII. Axes

A. Axes with a curved bit: n = 1 (whole)
One axe with a curved bit was recovered from a backhoe trench. The tool is similar in shape to an axe from site 41WM56, but the butt is made similar to another tool from the same site; that is, the biface is roughly triangular in shape, edges slightly convex, rounded butt, and the curved bit is made by flat medium secondary unifacial retouch.

B. Bifacially worked axe with a straight bit: n = 4 (3 whole)
One large bifacially worked axe was made on a large Sb flake; the bulb and platform were partly removed by retouch to form the butt. The distal end of the flake was carefully bifacially retouched into a slightly convex bit with a straight profile. One other axe was made on a Sb flake, and was bifacially retouched on the distal end of the flake only. The fragment and the fourth tool are bifacially retouched. All tools were found in San Geronimo levels.

C. More roughly bifacially worked axes: n = 2 (whole)
In the San Marcos levels of the site, two more possible retouched axes were found. One is more pear-shaped, slightly tapering towards the butt, with rounded extremities; the other one is rectangular. The axe bit for both tools is irregularly bifacially retouched.

XIV. Chopping Tools: n = 6 (whole)

Four tools were made on medium large and two on very large pebbles. Four were made by intensive bifacial retouch on a narrow extremity, the two others are naturally split pebbles, and the one flat face was used as a platform to retouch the other face of the bit.

XV. Scaled/Battered Pieces: n = 1

This artifact is a flake removed from a scaled/crushed piece. The typical retouch occurs on one face only.

XVI. Unifacials: n = 1

This tool fragment was made on a worn non-cortex flake fragment, the dorsal face completely covered by oblique very large retouch from both edges; one edge is also marginally retouched on the ventral face.

14.4 Debitage as an Index of Technological Change

by

Duane E. Peter

Introduction

Traditionally, the placement of Central Texas archaeological assemblages within a chronological scheme has relied upon diagnostic projectile points and infrequent radiocarbon dates. More recently, attempts have been made to relate the major modes of lithic reduction, bifacial core and prepared core, to particular segments of the cultural-historical sequence (Skinner and Gallagher 1974; Lynott and Peter 1977; Lynott 1978; Henry et al.1980). These attempts to correlate lithic debitage with particular time periods are motivated by the large number of sites within Central Texas which frequently do not yield radiocarbon dates or temporally limited projectile points. Some means of dating an assemblage is needed if settlement-subsistence patterns are to be discussed. Surface sites which have been extensively collected are particularly difficult to place chronologically. Testing of buried deposits does not always yield sufficient numbers of diagnostic tools either.

Although some success in relating bifacial core reduction to the Archaic period and prepared core reduction to the Neo-American period has been claimed (Skinner and Gallagher 1974), more recent evaluations of this hypothesis have demonstrated that such a relationship does not hold for the Hog Creek assemblages (Henry et al. 1980), the Aquilla Creek assemblages (Lynott and Peter 1977), or the Brazos Valley (Lynott 1978). It is unlikely that this relationship can be demonstrated elsewhere in Central Texas, either. Elsewhere, M. W. Pitts (1978:17-37) has attempted to segregate sites temporally by examining the relative breadth distribution of flakes. Pitts has split the breadth/length ratio of the flakes into several classes and then submitted these classes to multivariate techniques such as principal components and cluster analysis to ascertain the closeness of the various assemblages. Although Pitts' classes likely reflect the range of flake shape variability more accurately than the more traditional blade-flake dichotomy of a probable unimodal distribution, the arbitrary segmentation of such distributions has been recently questioned (Doran and Hodson 1975:171). Furthermore, a redefinition of the classes would likely alter the results of the cluster analysis (See discussion of cluster analysis in Chapter 14.2. Pitts' conclusions are also facilitated by the presence of distinctive blade and flake industries within the assemblages that he examined. It is highly unlikely that such a procedure could be successfully applied to the flake assemblages of Central Texas.

The concept of flake shape reflecting temporally related technological change may prove useful, however. It is proposed that an examination of

both quantitative and qualitative attributes of the lithic debitage from the San Gabriel assemblages may reveal significant temporal patterning. Dimensional attributes, such as length, width, size, and length/width ratio, are subjected to analysis of variance tests to determine the significance of the flake assemblage variability. Bulb and platform types are also recorded. An attempt is made to relate these characteristics to the metric variability.

Data Base

Six sites which represent the span of occupation for the respective reservoirs were originally chosen to provide the debitage samples for this analysis. The North Fork Reservoir was to be represented by the Hawes Site (41WM56), site 41WM53, and site 41WM73. The Cervenka site (41WM267), the Bigon-Kubala site (41WM258), and the Bryan-Fox site (41WM124) were to provide the samples from the Granger Reservoir. The need for a sufficient sample of complete flakes from a given excavation area of each site, however, immediately ruled out the inclusion of the Bigon-Kubala site and the Austin component at site 41WM53 in the analysis. Consequently, only five sites are involved (Table 14.4-1) Interestingly, the rejected Neo-American components from the Bigon-Kubala site contained sufficient quantities of lithic debitage; however, the debitage elements were predominantly fragments. The significance of this characteristic of these late components is presently unclear. Modern agricultural activities may have negatively affected the proportion of whole flakes. However, many of the levels analyzed were beneath the recent plow zone. Perhaps the reduction technology of the Neo-American period, although not noticeably different otherwise, merely resulted in the production of fragments as a primary by-product.

The quantity of whole flakes also affected the inclusion of certain flake categories for this analysis. Due to small sample sizes, primary flakes, biface thinning flakes and secondary flakes (>50% cortex), were not examined. Secondary flakes (<50% cortex), tertiary flakes, and microflakes (<1.5 cm) comprise the categorical framework for this analysis. Density of complete flakes was not high enough within the Granger Reservoir, however, for all three of these categories to be analyzed. From the Bryan Fox and Cervenka sites only secondary and tertiary flakes were analyzed.

Since the quantity of whole flakes varied significantly among the arbitrarily defined assemblages (arbitrary 10 cm levels within each excavation area) both a minimum sample to satisfy the goals of this analysis and the sampling procedures to select such a sample were determined. Establishing a practical, but adequate, sample size for this analysis was accomplished through experimentation with several test samples from the Hawes Site (41WM56). Using test samples from all three excavation areas from this site (Table 14.1-1) it was determined that a sample of 100 flakes from a given level of the three areas combined would adequately represent the

Table 14A-1. Assemblages Utilized for Flake Shape Analysis.

SITE/AREA		LEVELS/TIME PERIODS: TWIN SISTERS	SAN MARCOS	ROUND ROCK	CLEAR FORK	SAN GERONIMO
41WM56 HAWES	B			4,5	6,7	8,9,10
	C			4,5*	6,7,8,9	10
	E			3	4,5,6,7,	8,9
41WM267 CERVENKA	A				15-16 18-19	
	B		12		15-16 18-19	
	D				3-4 7	
41WM124 BRYAN FOX	A	16-19	28-31			
41WM53	A	3-4				
	C	3-4				
41WM73	B			12	17/17 19	

*Associated Radiocarbon Dates:

Hawes	3225 ± 75 B.P.	(UGa-2480)
	3615 ± 60 B.P.	(UGa-2485)
	3750 ± 90 B.P.	(UGa-2473)
Cervenka	4280 ± 240 B.P.	(Rl-1087)
Bryan Fox	1745 ± 85 B.P.	(UGa-2476)
41WM53	1155 ± 95 B.P.	(UGa-2471)
	1260 ± 150 B.P.	(UGa-2484)
41WM73	5285 ± 726 B.P.	(UGa-2482)

variability of the larger population of complete flakes from that level. To provide an even number of flakes from each excavation area a total of 102 complete flakes were analyzed from each level or 34 from each respective area. In order to maintain a balanced cell design for the eventual nested analysis of variance design, 51 flakes were analyzed from each excavation area when only two areas were involved.

In those sites where the quantity of complete flakes was high, the sample of flakes from each area was selected by means of a random sample of the excavation quads of each arbitrary 10 centimeter level. The number of excavation quads utilized varied, for only those units necessary to produce 34 or 51 complete flakes were analyzed. Analysis was always terminated when the required number of complete flakes had been examined even though additional specimens were available from the excavation quad being analyzed. Although this procedure may have introduced a small measure of selective bias on the part of the analyst, a balanced cell design was maintained for the eventual nested analysis of variance design. Unfortunately, such high densities were not always a problem. At sites 41WM267 and 41WM124 the low density of debitage required that levels be collapsed together to provide a sufficient number of specimens. Since the analysis is oriented toward recognizing technological trends, the lack of sample unit comparability with the other sites is not as critical as it may seem. The collapsed units at each of these sites represent portions of homogeneous cultural stratigraphic units.

Attributes

Six attributes, four metric and two categorical observations, are proposed for this analysis. A sliding calipers was used to measure the length and width of each specimen to the nearest millimeter. Length was measured at the maximum dimension of the flake parallel to the striking force. Width was measured at the maximum dimension of the flake perpendicular to the striking force. Size of a flake is calculated by dividing the product of the length and width of the specimen by ten (Size - L X W / 10). The remaining metric variable is the calculated length/width ratio (L/W).

Variability of the bulb of percussion and striking platform provide the qualitative variables for the analysis. Bulb type was evaluated according to its degree of prominence in relation to flake size. Three categories (flat, medium, and heavy) were recognized. If the analyst had any question concerning the assignment of a bulb type to a particular specimen, the "medium" category was utilized. The subjective nature of such an evaluation proved to severly restrict the usefulness of this attribute. Platform type, on the other hand, was categorized into four mutually exclusive classes:

1) Cortex - striking platform is unaltered; original cortex surface is present.

2) Single facetted - single flake scar forms the striking platform surface.

3) Multiple facetted - two or more flake scars form the striking platform surface.

4) Crushed - most of the platform surface was destroyed on impact; only a remnant remains.

Statistical Analysis

The initial step of analysis is designed to assess intra-site variability prior to the inter-site comparisons. Since some of the sites contained several excavation areas, a nested analysis of variance design was utilized to evaluate the possible replicative effect of the area variability on the level variability. Within this design, the arbitrary levels are treated as fixed effects and the areas are treated as random nested effects within the levels. The Biomedical Program package, BMDP2V (Dixon 1975: 711-725), was utilized to accomplish this task. Sum of squares values and F-statistics are presented for the area, level, and area-level interaction effects, respectively (Table 14.4-2).

Prior to the analysis of variance tests, scattergrams were produced for selected samples of complete flakes in order to detect the presence of isolated extreme cases that might unduly affect the analysis of variance results. It was decided that all flakes greater than six centimeters in length would be recorded but not included within the ANOVA analysis. Within the Granger Reservoir assemblages only three flakes were encountered that were larger than 6.0 centimeters. Within the North Fork Reservoir the several levels of areas B, C, and E of the Hawes Site yielded 24 flakes larger than 6.0 cm; site 41WM53 yielded only six.

Four dependent variables were submitted to analysis of variance. These variables were length, width, size, and the length/width ratio. The nested ANOVA analysis was conducted on each available flake type (secondary, tertiary, and micro-elements) at sites with multiple excavation units (41WM56, 41WM53, 41WM267). Secondary flakes exhibited no significant intra-site variability either temporally or spatially in any of these sites. Tertiary and micro-flakes (Table 14.4-2) exhibited significant level differences for the variable, size, at the Hawes Site (41WM56). Examination of the cell means (Fig. 14.4-1) for the tertiary flakes reveals that this significance derives from the low size values in levels 5 and 6 of Areas B and C and level 3 of Area E. Level 3 of Area E and level 5 of Areas B and C were previously recognized as Round Rock assemblages on the basis of projectile point

Table 14.4-2. Nested ANOVA Analyses of Flake Samples from North Fork and Granger Assemblages Which Exhibited Significant Areal or Level Variability.

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F-RATIO	PROB. F EXCEEDED
Site 41WM56 Tertiary Flakes Variable=Size	Mean	2212382.602	1	2212382.602	1325.758	.000
	Area	1213.337	2	606.668	.364	.695
	Level	22937.699	6	3822.950	2.291	.034
	Area-Level Interaction	21224.717	12	1768.726	1.059	.392
	Error	1156456.216	693	1668.768		
Site 41WM56 Micro-Flakes Variable=Size	Mean	102580.935	1	102580.935	6930.180	.000
	Area	33.734	2	16.867	1.140	.321
	Level	204.137	6	34.023	2.299	.033
	Area-Level Interaction	315.668	12	26.306	1.777	.048
	Error	10257.827	693	14.802		
Site 41WM53 Tertiary Flakes Variable=Size	Mean	313440.007	1	313440.007	285.423	.000
	Area	6513.658	1	6513.658	5.931	.016
	Level	278.449	1	278.449	.254	.615
	Area-Level Interaction	1627.031	1	1627.031	1.482	.226
	Error	144957.015	132	1098.159		
Site 41WM267 Tertiary Flakes Variable=Width	Mean	107778.044	1	107778.044	1858.856	.000
	Area	135.088	2	67.544	1.165	.314
	Level	261.574	1	261.574	4.511	.035
	Area-Level Interaction	24.088	2	12.044	.208	.813
	Error	11480.206	198	57.981		
Site 41WM267 Tertiary Flakes Variable=Length/Width	Mean	339.631	1	339.631	2914.483	.000
	Area	.479	2	.239	2.055	.131
	Level	1.091	1	1.091	9.364	.003
	Area-Level Interaction	.658	2	.329	2.823	.062
	Error	23.073	198	.117		

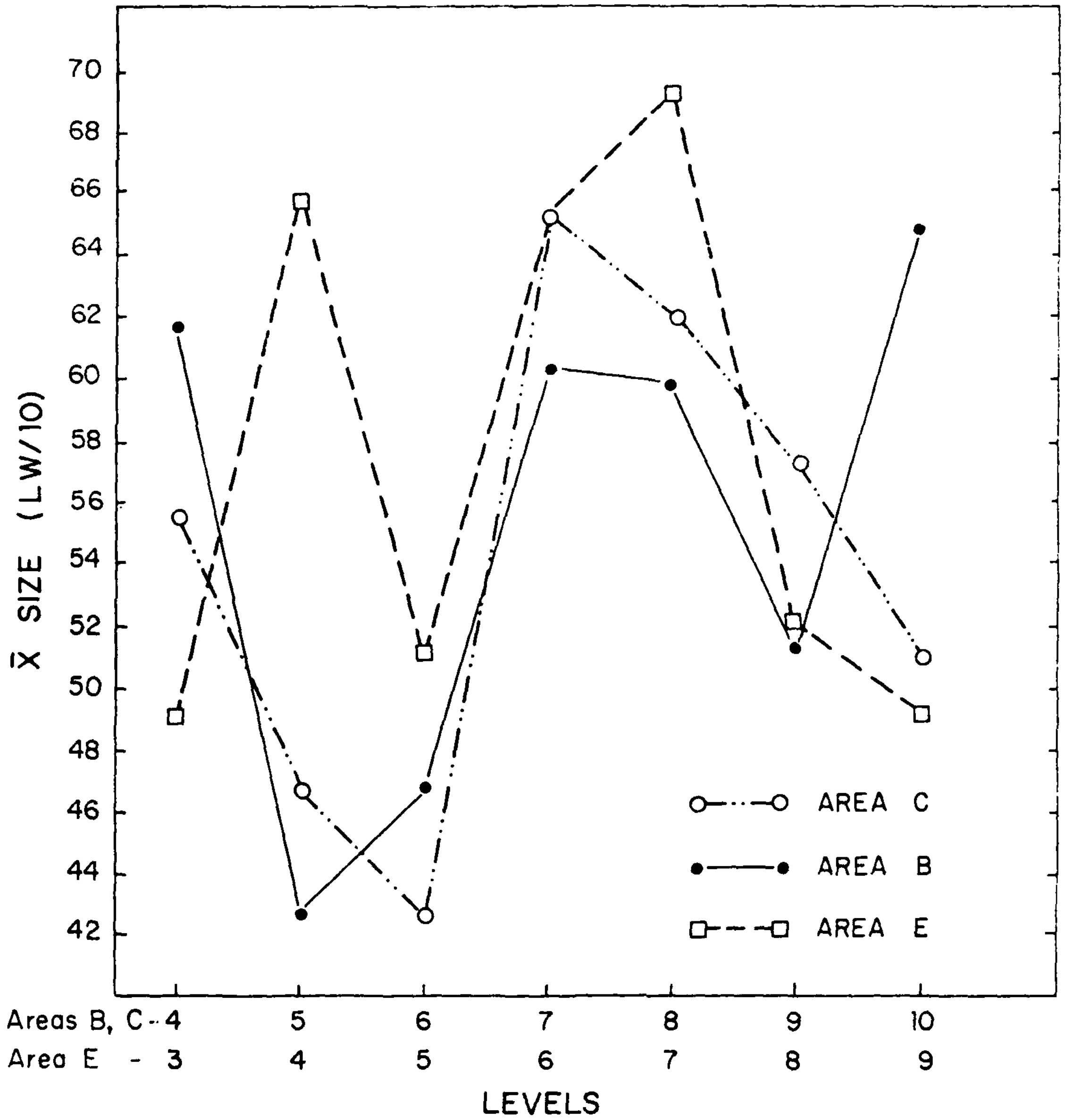


Figure 14.4-1. Comparisons of Debitage Size, 41WM56

distributions. Level 6 of both areas had been designated as part of the Clear Fork component. Since the smaller size of the flakes is limited to these levels, the stratigraphic division of these levels may be incorrect on the basis of reduction technology. Unfortunately, several other variables may also be contributing to this difference. Maintenance or rejuvenation of tools may have been a more predominant activity during these occupations. Consequently, flake size would be smaller. Reduction of a blank may have also been accomplished elsewhere so that only smaller finishing flakes would be deposited.

The micro-flakes also exhibit significant level variability. However, the levels contributing to this variability are not so neatly clustered. Levels 4 and 5 of Area B, levels 4 and 6 of Area C, and levels 3 and 6 of Area E exhibit lower mean size values (Fig. 14.4-2) than the remaining cells. Such variability is probably insignificant as far as temporal trends are concerned. A greater amount of tool maintenance or rejuvenation is likely reflected by this patterning.

Elsewhere in the North Fork Reservoir at site 41WM53, the nested analysis of variance design demonstrated that the tertiary flakes exhibited significant areal variability (Table 14.4-1, Fig. 14.4-3) for the variable, length and consequently flake size. Level variability was, perhaps, masked by the transitional nature of the sampled assemblages (Austin/Twin Sisters). This areal difference most likely reflects activity differences across the site, for Area C sampled a less utilized, peripheral area of the site.

At the Cervenka Site (41WM267) within the Granger Reservoir, the nested ANOVA design could only be applied to the deeper assemblages within the Clear Fork component. Although the selected levels sampled only a small span of the Clear Fork component, the mean width of the tertiary flakes, and consequently the length/width ratio (Table 14.4-2) exhibited significant level differences in all three areas. During this portion of the Clear Fork component the width of the flakes became narrower. Unfortunately, the limitations of this sample do not allow any projection of a long-term trend. Consequently, a one-way analysis of variance test was conducted on the samples from Area B alone so that the later San Marcos Phase data might be examined in relation to this problem. There is a significant trend within Area B, but it is related to length and size variables of the secondary elements rather than the tertiary elements. The secondary elements of the San Marcos component are significantly smaller than those of the Clear Fork component (Table 14.4-3). Tertiary flakes remain the same size, however. This variability may be related to the differential utilization of available resource areas or differential patterning of the decortication phase of the reduction process.

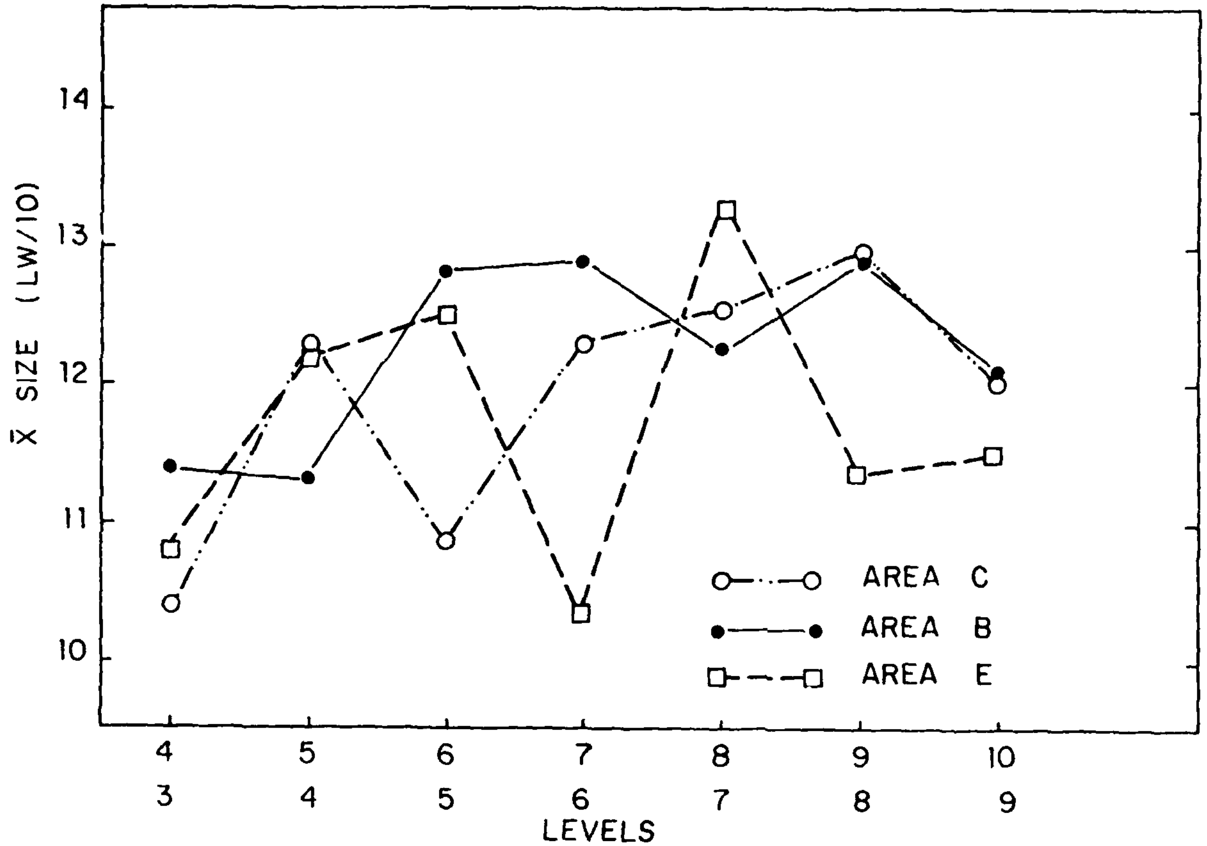
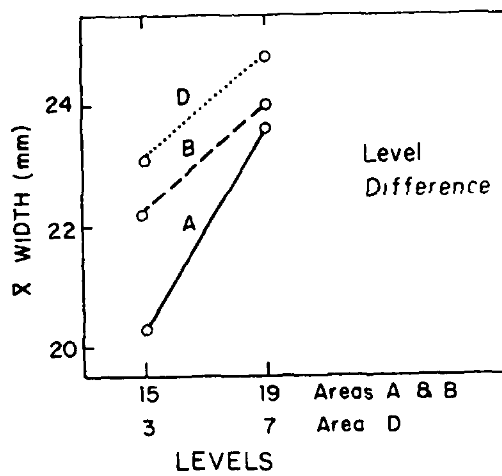
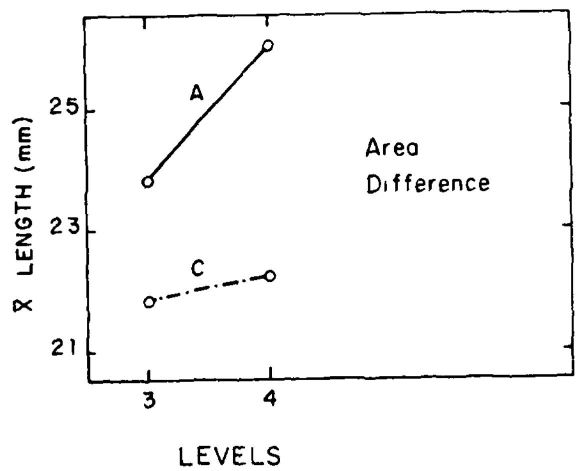


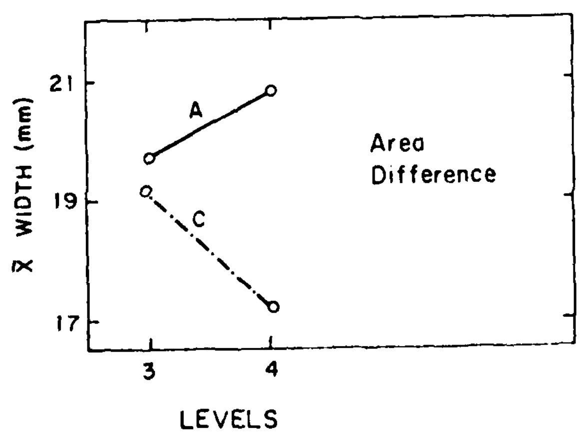
Figure 14.4-2. Comparison of Micro-flake size, 41WM56



41 WM 267



41 WM 53



41 WM 53

Figure 14.4-3. Tertiary Flake Variability

Table 14.4-3. One-Way Analysis of Variance of Length and Size of Secondary Flake Sample from Area B, Site 41WM267.

Variable Length by Level

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	1114.5882	577.2941	5.6434	.0048
Within Groups	99	9776.3235	98.7507		
TOTAL	101	10890.9118			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
12	34	27.3235	9.4987	24.0093 TO 30.6378
15	34	34.7353	10.0794	31.2184 TO 38.2522
19	34	33.8529	10.2194	30.2873 TO 37.4186

Variable Size by Level

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	22747.0202	11373.5101	3.3188	.0403
Within Groups	99	339270.7006	3426.9768		
TOTAL	101	362017.7208			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
12	34	73.3000	62.9718	51.3281 TO 95.2719
15	34	108.7735	57.9842	88.5419 TO 129.0052
19	34	98.7676	54.3443	79.8060 TO 117.7293

Interestingly, the one-way ANOVA analysis of the Round Rock and Clear Fork samples from Area B of site 41WM73 exhibited an opposite trend. Although the differences are not significant, it is clear that the early Clear Fork secondary flakes are smaller than the later specimens (Table 14.4-4). This difference is likely site specific, however, for the examination of the secondary flakes from site 41WM56 showed no significant variability between the Round Rock and Clear Fork components. Within the Granger Reservoir, however, the San Marcos component sample from the Bryan Fox Site exhibits a mean size value (74.1) for secondary flakes which is close to that of the San Marcos sample from Area B of the Cervenka Site (Table 14.4-3). The standard deviation value (52.7) and the .95 confidence interval for the mean (59.3-88.9) also indicate a similar range of variability.

The trend toward smaller flakes during the later San Marcos Phase is therefore not site specific in the Granger Reservoir.

Table 14.4-4 One-Way Analysis of Variance of Size of Secondary Flake Sample from Area B, Site 41WM73.

Variable Size by Level

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	9650.2320	4825.1160	1.8107	.1689
Within Groups	99	263807.5265	2664.7225		
TOTAL	101	273457.7584			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
12	34	81.6265	65.3470	58.8258 TO 104.4271
15	34	67.4000	41.3840	52.9605 TO 81.8395
19	34	57.9618	44.8476	42.3137 TO 73.6098

It is evident from the above discussion that no trends in flake size and shape are readily apparent from a strictly temporal overview for both reservoirs. If there is a temporal trend within the Granger Reservoir, it is likely related to the area's access to raw materials rather than any technological shifts. The patterning of the variability in flake size and shape is clearly related to a spatial context (the two reservoirs) rather than a temporal context. An examination of Figure 14.4-4 presents the mean size values for secondary and tertiary flakes by time period and reservoir demonstrates that the only noticeable trend is the generally larger size of these elements within the Granger Reservoir sites.

Before this inter-reservoir variability can be fully evaluated, however, it is necessary to assess the inter-site variability within each reservoir. One-way analysis of variance was utilized to evaluate the variability of assemblages from the same temporal periods. Within the North Fork Reservoir the analysis focused upon the relationships between sites 41WM56 and 41WM73. The Round Rock stratigraphic units of the respective sites exhibited no significant differences. The comparison of the flake samples from the Clear Fork components, however, consistently demonstrated that the level 19 samples of secondary and tertiary flakes from site 41WM73 are significantly smaller than those samples from site 41WM56 (Tables 14.4-5 to 14.4-12). The similarities between the site 41WM73 samples (Early Clear Fork) and levels 9 and 10 of Area B, site 41WM56 (Fig. 14.4-4) indicate that the basal assemblage at site 41WM73 is likely earlier than the Clear Fork assemblage within Area C

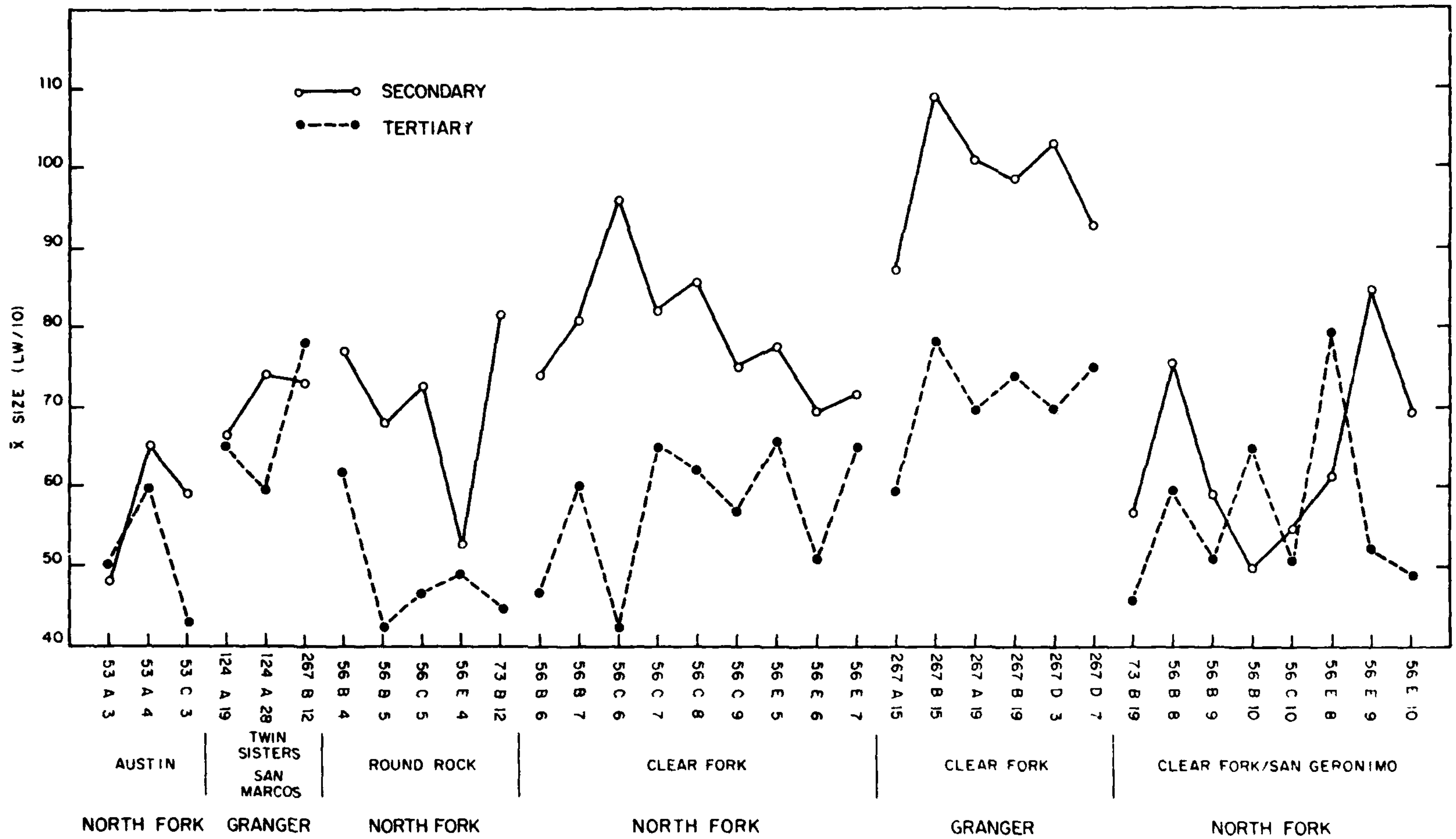


Figure 14.4-4. Debitage Mean Size Values.

of the Hawes site. Consequently the early date of 5285 ± 726 B.P. may not be totally unrealistic. Within the Granger Reservoir only one comparison could be made between the San Marcos components of sites 41WM124 and 41WM267. No significant differences were noted between these two assemblages.

The inter-reservoir comparisons by means of one-way analysis of variance reflect the relationships that may be perceived from Figure 14.4-4 . Significant differences between the tertiary flakes from site 41WM124 (level 19) and site 41WM53 (levels 3 and 4) are very noticeable. Although this difference could be temporally related (Table 14.4-1) the lack of a significant temporal trend within the North Fork Reservoir assemblages makes the spatial context a more viable factor in explaining such differences.

Table 14.4-5. Flake Shape Comparison of Clear Fork 56E6, 56C9, 73B19

Variable Length (Tertiary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	564.9405	282.4702	2.985	0.0051
Within Groups	99	9369.7283	94.6437		
TOTAL	101	9934.6680			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	26.8823	11.7519	22.7819 TO 30.9827
56C9	34	25.5294	8.7568	22.4740 TO 28.5848
73B19	34	21.3529	8.3153	18.4516 TO 24.2543

Variable LWRAT (Tertiary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	1.1443	0.5722	3.794	0.0258
Within Groups	99	14.9280	0.1508		
TOTAL	101	16.0723			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	1.4062	9.4315	1.2557 TO 1.5568
56C9	34	1.2649	0.3850	1.1306 TO 1.3993
73B19	34	1.1471	0.3434	1.0273 TO 1.2669

Table 14.4-6. Flake Shape Comparison of Clear Fork 56E6, 56C9, 73B19

Variable Length (Microflake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	41.8235	20.9118	3.422	0.0366
Within Groups	99	604.9699	6.1108		
TOTAL	101	646.7935			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	10.2647	2.5383	9.3791 TO 11.1504
56C9	34	11.7647	2.6176	10.8514 TO 12.6780
73B19	34	11.4118	2.2444	10.6286 TO 12.1949

Variable Size (Microflake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	136.1875	68.0938	4.361	0.0153
Within Groups	99	1545.6575	15.6127		
TOTAL	101	1681.8450			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	10.3059	3.5472	9.0682 TO 11.5435
56C9	34	12.9882	4.2970	11.4889 TO 14.4875
73B19	34	12.4294	3.9739	11.0428 TO 13.8159

Table 14.4-7. Flake Shape Comparison of Clear Fork 56E6, 56C8, 73B19

Variable Length (Secondary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	693.8884	346.9441	3.356	0.0389
Within Groups	99	10233.3447	103.3671		
TOTAL	101	10927.2305			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	26.3823	9.2212	23.1649 TO 29.5998
56C8	34	29.8235	10.9557	26.0009 TO 33.6461
73B19	34	23.4412	10.2490	

Variable Size (Secondary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	13124.3882	6562.1914	2.994	0.0546
Within Groups	99	216951.4883	2191.4290		
TOTAL	101	230075.8750			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	71.9058	42.7807	56.9789 TO 86.8327
56C8	34	85.7470	52.2761	67.5070 TO 103.9869
73B19	34	57.9617	44.8476	42.3136 TO 73.6097

Table 14.4-8. Flake Shape Comparison of Clear Fork 56E6, 56C8, 73B19

Variable Length (Tertiary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	585.7246	292.8623	3.103	0.0493
Within Groups	99	9344.1990	94.3858		
TOTAL	101	9929.0219			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	26.8823	11.7519	22.7819 TO 30.9827
56C8	34	25.8235	8.7125	22.7836 TO 28.8634
73B19	34	21.3529	8.3153	18.4516 TO 24.2543

Variable LWRAT (Tertiary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	1.1459	0.5729	3.813	0.0254
Within Groups	99	14.8748	0.1503		
TOTAL	101	16.0207			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	1.4062	0.4315	1.2557 TO 1.5568
56C8	34	1.2623	0.3829	1.1287 TO 1.3959
73B19	34	1.1471	0.3434	1.0273 TO 1.2669

Table 14.4-9. Flake Shape Comparisons of Clear Fork 56E6, 56C8, 73B19

Variable Length (Microflake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	41.8235	20.9118	3.744	0.0271
Within Groups	99	552.9700	5.5856		
TOTAL	101	594.7935			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	10.2647	2.5383	9.3791 TO 11.1504
56C8	34	11.7647	2.2970	10.9632 TO 12.5662
73B19	34	11.4118	2.2444	10.6286 TO 12.1949

Variable Size (Microflake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	108.3454	54.1727	3.505	0.0338
Within Groups	99	1529.9844	15.4544		
TOTAL	101	1638.3296			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E6	34	10.3059	3.5472	9.0682 TO 11.5435
56C8	34	12.5500	4.2414	11.0701 TO 14.0298
73B19	34	12.4294	3.9739	11.0428 TO 13.8159

Table 14.4-10 Flake Shape Comparison of Clear Fork 56E4, 56C6, 73B19

Variable Width (Secondary Flakes)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	746.7245	373.3621	3.510	0.0337
Within Groups	99	10530.2500	106.3661		
TOTAL	101	11276.9727			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E4	34	23.6470	9.5786	20.3049 TO 26.9892
56C6	34	28.7647	12.4000	24.4381 TO 33.0913
73B19	34	22.5588	8.5783	19.5657 TO 25.5519

Variable Size (Secondary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	24571.1321	12285.5625	3.088	0.0500
Within Groups	99	393836.7500	3978.1489		
TOTAL	101	418407.8750			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E4	34	77.6881	65.2735	54.9132 TO 100.4631
56C6	34	95.9705	75.2496	69.7147 TO 122.2263
73B19	34	57.9617	77.8476	42.3136 TO 73.6097

Table 14.4-11. Flake Comparison of Clear Fork 56E4, 56C6, 73B19

Variable Length (Tertiary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	642.4356	321.2178	4.311	0.0160
Within Groups	99	7376.7258	74.5124		
TOTAL	101	8019.1602			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E4	34	26.9706	9.5900	23.6245 TO 30.3167
56C6	34	22.0000	7.9009	19.2432 TO 24.7567
73B19	34	21.3529	8.3153	18.4516 TO 24.2543

Variable Width (Tertiary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	395.8437	197.9219	3.387	0.0378
Within Groups	99	5785.4028	58.4384		
TOTAL	101	6181.2461			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E4	34	23.1765	9.3500	19.9141 TO 26.4388
56C6	34	18.5882	5.3999	16.7041 TO 20.4723
73B19	34	19.5882	7.6638	16.9142 TO 22.2623

Table 14.4-12. Flake Shape Comparison of Clear Fork 56E4, 56C6, 73B19

Variable Size (Tertiary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	10657.4653	5328.7305	4.661	0.0116
Within Groups	99	113192.2656	1143.3562		
TOTAL	101	123849.6875			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E4	34	65.9176	37.8361	52.7159 TO 79.1192
56C6	34	42.5646	25.1646	33.7843 TO 51.3449
73B19	34	46.4205	36.9491	33.5284 TO 59.3127

Variable Length (Microflake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	31.3722	15.6861	2.960	0.0564
Within Groups	99	524.5876	5.2989		
TOTAL	101	555.9597			

LEVEL	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
56E4	34	11.4118	2.5360	10.5269 TO 12.2966
56C6	34	10.2353	2.1042	9.5011 TO 10.9695
73B19	34	11.4118	2.2444	10.6286 TO 12.1949

Comparisons of the Clear Fork components were limited to Area C of the Hawes Site, Areas A, B and D of the Cervenka Site, and Area B of site 41WM73. Interestingly, no significant differences were noted between Area C of the Hawes site and the upper levels of the three areas of the Cervenka site, even though the flakes are consistently larger within the Cervenka assemblage. There are significant differences between the tertiary flake samples of these two sites, if the lower flake samples from the Cervenka site are considered. This significance, however, is dependent upon the low size values for levels 6 and 9 of Area C of the Hawes site. As readily seen in Figure 14.4-4 the flake sample from site 41WM73 is significantly smaller than any of the samples from the Cervenka Site. Although the comparisons between the two reservoirs do not always provide consistent results, one may safely conclude that flake size within the Granger Reservoir sites is consistently larger than that of the North Fork Reservoir sites. Statistically, the difference is not always significant. Nevertheless, the spatial patterning of flake size is observable. The lack of greater consistency between assemblages for flake size variability reflects the complex of factors that may affect flake size. The nature and size of available raw material, differential activity areas within a site, differential activities between sites, and the idiosyncracies of the flintknapper are just a few of the factors that may determine flake size.

From a technological perspective the variability displayed by the bulb and platform types in relation to the above variables should be

more sensitive indicators of technological change than flake size alone. The subjective assessment of the bulb type (flat, medium, heavy) relative to flake size, however, does not provide an objective data base for a statistical comparison. For this reason, the relationship of the metric dimensional variable, size, to platform type (cortex, single, facetted, crushed) alone was evaluated by means of one-way analysis of variance. The stratigraphic sequence within Area C of the Hawes site was used for this evaluation. Surprisingly, the analysis of variance test denoted the lack of any significant variability associated with the four platform types of the 714 secondary flakes analyzed from the sevel levels (Table 14.4-13). Analysis of the tertiary flakes produced the same results. The lack of any strong relationship between platform type and flake size renders the possibility of a temporal trend concerning such relationships quite remote. Individual levels (5 and 8) were also analyzed to detect any potential trends that might have been masked by the analysis of all the level samples simultaneously. No changes in the relationship of flake size to platform type were revealed.

A comparison of the frequencies of the platform types by level (Table 14.4-14) demonstrates that the variability of platform types for secondary flakes is relatively constant throughout the stratigraphic sequence. The Chi-square test of the tertiary flake platform types, however, indicates that there is significant variability among the level samples. An examination of a cumulative percentage graph of platform types by level (Fig. 14.4-5) demonstrates that this variability

Table 14.4-13 One-Way Anova of Platform Types

Variable Size by Platform (Secondary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	3	20059.5280	6686.5093	2.0594	.1043
Within Groups	710	2305250.8017	3246.8321		
TOTAL	713	2325310.3297			

PLATFORM	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
Cortex	174	63.2586	48.1970	56.0468 TO 70.4704
Single	293	76.4857	63.6994	69.1616 TO 83.8098
Facetted	113	71.8274	48.1197	62.8583 TO 80.7965
Crushed	134	68.6507	58.7604	58.6104 TO 78.6911

Table 14.4-14

Frequency of Platform Types of Secondary and Tertiary Flakes by Level, Area C, Site 41WM56.

	4		5		6		7		8		9		10	
	SEC	TER	SEC	TER	SEC	TER	SEC	TER	SEC	TER	SEC	TER	SEC	TER
Cortex	28	-	22	-	28	-	25	-	22	-	25	-	24	-
Single facetted	43	44	33	35	39	42	43	44	50	54	39	53	41	37
Multiple facetted	9	25	24	31	17	31	14	34	17	27	14	31	18	46
Crushed	22	33	18	36	18	29	20	24	13	21	24	18	19	19

Chi-Square Test of Secondary Flakes by Level.

$X^2 = 15.56$

D.F. = 18

Probability = .62385

Chi-Square Test of Tertiary Flakes by Level.

$X^2 = 27.39$

D.F. = 12

Probability = .00752

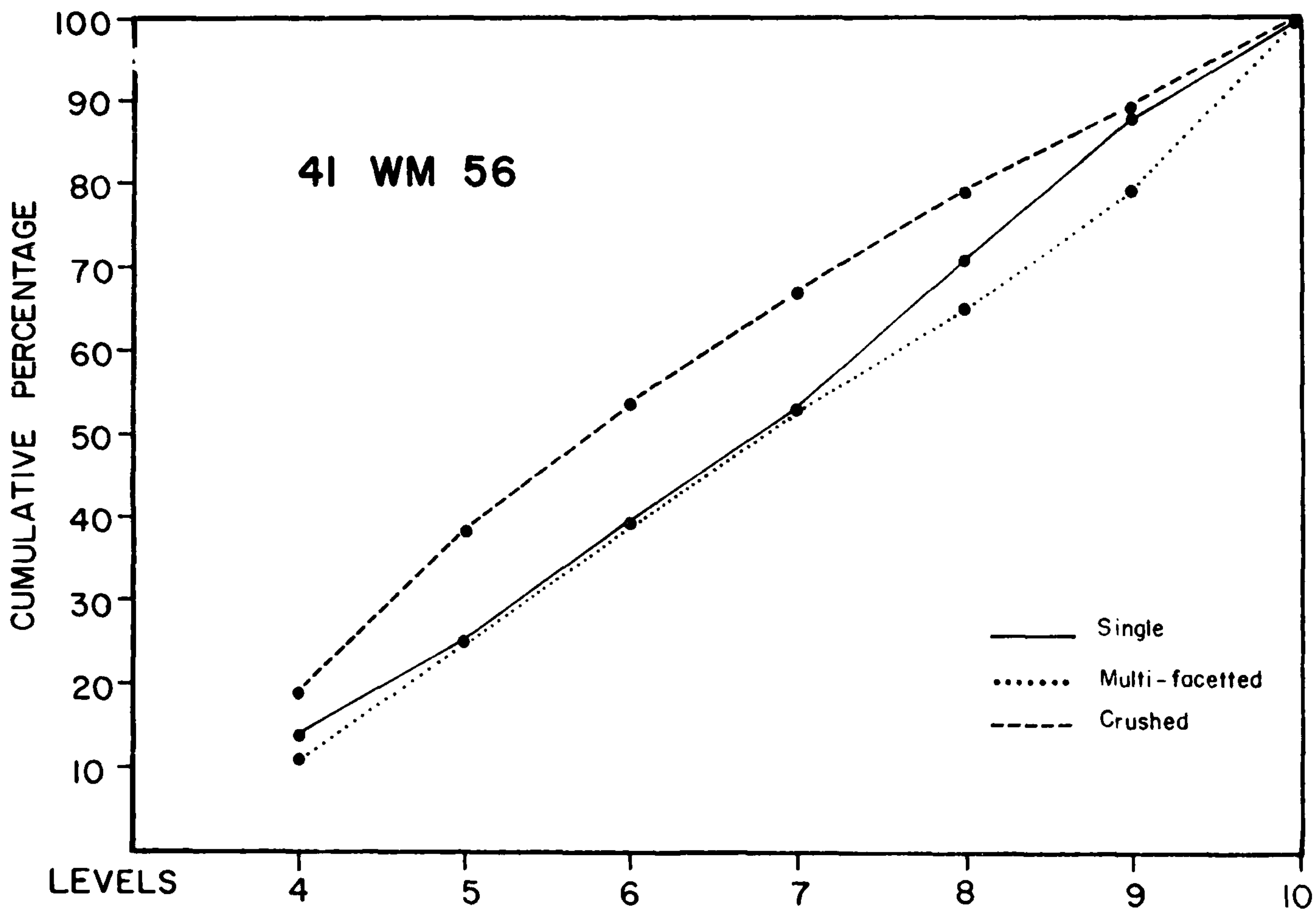


Figure 14.4-5. Cumulative Graph of Platform Types

Variable Size by Platform (Tertiary Flake)

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F-RATIO	F-PROB
Between Groups	2	4528.0266	22640133	1.3444	.2613
Within Groups	711	1197303.9411	16839718		
TOTAL		1201831.9676			

PLATFORM	COUNT	MEAN	STANDARD DEVIATION	95 PCT CONF INT FOR MEAN
Single	309	54.0087	37.9049	49.7657 TO 58.2518
Facetted	225	59.3764	44.8814	53.4802 TO 65.2727
Crushed	180	53.8683	41.1810	47.8114 TO 59.9253

is produced by changes in the relative proportions of the types in levels 5, 8, 9, and 10. In level 5 there is an increase in crushed platform at the expense of single platforms. In levels 8 and 9 the flakes with single platforms increase in great numbers relative to the remaining types. In level 10 the multi-facetted platforms are found on the greatest proportion of the flakes. Whether or not these differences reflect temporal trends within the reduction technology or merely reflect samples of different aspects of the reduction process is not clear. However, the latter is judged to be more likely. Only a more detailed analysis of the whole range of samples (temporally) from a number of San Gabriel assemblages will adequately determine the significance of this variability.

Conclusion

The previously discussed analysis revealed no significant temporal trends concerning flake shape and platform type within the San Gabriel assemblages. Significant differences were noted between selected assemblages within the North Fork and Granger Reservoirs, respectively. These inter-assemblage differences, however, cannot be related to a single explanatory factor. A complex of factors such as the nature and size of available raw material, differential reduction strategies between sites, and the personal choice of the flintknapper would produce a certain amount of variability within the debitage assemblage which would not necessarily be connected to diachronic changes in the reduction technology. The intra-site variability within sites 41WM53 and 41WM56 is clearly demonstrative of variability that is not temporally related. Significant inter-areal variability was exhibited by the flake samples from site 41WM53. The inter-areal differences at site 41WM56 were not significant. However, various samples from the site more closely resembled the samples from other sites than some of the samples from within site 41WM56.

The only generalized pattern noted within the assemblages sampled from the two reservoir areas is that the flakes within the Granger Reservoir assemblages are generally larger than those recovered from the North Fork assemblages. Given a knowledge of the raw material resource areas within both reservoirs, this pattern of flake size seems illogical. For example, the upland areas bordering the North Fork drainage provide numerous large cobbles of flint (10-40 cm in breadth). Beds of flint which are 10 centimeters thick are also exposed along the upland ridges.

Within the Granger Reservoir area raw material can be obtained from the gravels within the streambed, from the cherty prairie soils found in the upland areas bordering the San Gabriel drainage, and possibly from the Pleistocene gravel beds which may have been exposed at various points in the valley. Given the derived nature of the streamed cobbles or the flint nodules in the upland prairie soils, one would not expect their size to approach the upper size range of the raw materials in the North Fork drainage. Hence, one might expect flake size to be smaller within the Granger Reservoir assemblages. Of course, this latter expectation has already been demonstrated to be false. Consequently, the first premise that the raw materials would be smaller in the Granger Reservoir area may also be false.

The assumption that the nodules of raw material of the Granger Reservoir area would be smaller than those of the North Fork drainage was tested by examining the cores from the Cervenka Site (41WM267) and the Hawes Site (41WM56), respectively. Since the cores had been partially utilized, only an approximation of the original nodule size can be observed. To partially negate the problem of differential core utilization, only those cores displaying cortex on more than 70 percent of their surface area were compared (Table 14.4-15). Three dimensional variables of the cores are presented: (1) length, (2) width, and (3) thickness. A size index (Length x Width x Thickness/10) is also presented for each specimen. All measurements were rounded to the nearest whole centimeter before they were entered into the size equation. Examination of Table 14.1-15 demonstrates that the cores from the Cervenka site display a range of size variability equal to or greater than those of the Hawes site. The raw materials brought to these sites were roughly equivalent in size.

One is still left with the problem of explaining the differential flake size between the two reservoir areas. The most probable explanation is that the initial reduction of raw material took place at the site within the Granger Reservoir area while in the North Fork drainage, the initial reduction took place on the upland ridges. The expansive quarry sites on the upland ridges parallel to the North Fork River attest to the fact that the raw material was likely broken down into useful sizes before being transported to the sites for further reduction.

Within the Granger Reservoir area the flint cobbles were likely

Table 14.4-15 Comparison of Core Dimensions, the Cervenka Site (41WM267) and the Hawes Site (41WM56)

CERVENKA SITE

CORE ATTRIBUTE	SPECIMEN 1	2	3	4	5	6	7	8	9	10	11	12	13
Length	9.0	9.2	7.4	8.2	3.2	8.5	9.6	9.2	7.1	3.3	8.3	6.4	4.8
Width	12.7	9.6	9.4	9.1	6.6	6.3	8.5	6.8	6.6	4.6	7.2	7.8	5.8
Thickness	4.4	4.1	3.9	10.3	10.4	5.7	6.1	5.0	5.4	2.6	4.5	4.2	2.5
LWT/10	47	36	25	72	21	32	54	32	25	5	28	19	9
% Cortex	70	80	80	80	90	75	75	70	75	70	80	80	75

HAWES SITE

CORE ATTRIBUTE	SPECIMEN 1	2	3	4	5	6	7	8	9	10	11
Length	4.5	8.0	5.0	5.6	10.6	4.8	2.5	3.9	4.8	10.1	4.0
Width	8.5	4.5	10.0	8.0	9.3	7.2	12.1	7.7	8.7	8.3	2.1
Thickness	9.0	2.5	6.6	2.5	4.8	3.7	6.1	3.5	3.3	5.4	4.7
LWT/10	41	12	35	14	50	14	22	13	14	40	4
% Cortex	75	75	75	90	80	70	70	75	90	90	80

reduced at the site. Previous studies of lithic source areas in the Granger Reservoir have demonstrated that there is a strong similarity between the lithic material at a given site and the lithic source area nearest that site (Bond 1978:272-283). Quarry sites do exist within the upland areas. However, the density of human altered cobbles and flakes is almost insignificant when compared to the North Fork quarry sites. At some of the purported upland quarry sites (Site 41WM286) many of the cracked cobbles are the result of recent agricultural activites rather than the product of a prehistoric flintknapper. Cobbles from the streambed were the most likely source of raw material within the Granger Reservoir.

The relationship of the raw materials within the sites to the lithic source areas needs to be further examined. The initial efforts of McGinley (1978) and McGinley and Schweikert (1979) involving neutron activation analysis of flints from the Edwards Formation provides a viable means of testing the above hypothesized relationships. McGinley's trace element analysis of four flint samples from the San Gabriel River valley demonstrated that trace element differences could be detected among the four sample sites. Bond's (1978:272-283) utilization of a color attribute analysis of the cherts within the Granger Reservoir, although a less exacting approach due to observer variability, also provided a means of discriminating lithic source areas. Both of these approaches, if applied on a much larger scale within the San Gabriel River valley, would provide important information concerning the interrelationships between the lithic material within the archaeological context and the lithic source areas.

14.5 Chi-Square Debitage Comparisons

by

T. R. Hays and James Thomson

Introduction

After the debitage analysis was completed and final tabulations were complied, a more thorough investigation of each site area was performed using Chi-square. It is not practical to provide the more than 420 individual Chi-square results in this report, therefore only the final intra- and inter-reservoir values by site will be presented. Level totals were used for vertical testing with the same debitage categories as in the field studies (Chapter 6.1).

With the aid of a Processor Technology Sol System III-A micro-computer and a Teletype Model 43 Teleprinter, using a modified software program, Chi-square investigations proceeded at a faster pace due to the automatic matrix set-up capabilities not offered with the TI-59 calculator. The software will require further modifications to include creation and manipulation of data files for tool, debitage, faunal or any other archaeological information before the system is completely operational. However, the current program version, although still repetitive in its data entry, provides the necessary capabilities with less effort by the operator than does the TI-59.

It should be pointed out that the non-tool lithic information was not available for full analysis until several months after the close of the field season. A majority of that time was used to complete the analysis of materials excavated near the end of the field season, reanalyzing some of the North Fork materials from the beginning of the field season and compiling and preserving all of the information on laboratory forms which exhibit the data at various stages of summation. More material was collected than anticipated (over half a million non-tool lithic pieces) which necessitated a greater effort to preserve the information for future research.

After the data was in a workable form, duplication of this information for preservation purposes, performed by keypunching on standard 80-column IBM cards, was a primary task while Chi-square and flake shape analysis was in progress. The format and coding of these cards are provided in Table 14.5-1 for future reference. They contain more types of observations on the debitage than were statistically investigated for this report, aside from those used as a possible index of technological change (Chapter 14.4).

Table 14.5-1. Debitage Codes and IBM Card Format.

DEBITAGE CATEGORY CODES

1	Primary Flake	9	Micro Flakes	17	Burinspalls
2	Secondary a Fl.	10	Micro Bl. - Sec. a	18	Cores
3	Secondary b Fl.	11	Micro Bl. - Sec. b	19	Core Frag.
4	Tertiary Fl.	12	Micro Bl. - Tert.	20	Core Trim. Fl.
5	Secondary a Blade	13	Bladelets - Sec. a	21	Chips
6	Secondary b Bl.	14	Bladelets - Sec. b	22	Chunks
7	Tertiary Bl.	15	Bladelets - Tert.	23	Other
8	Broken Bl.	16	BTF		

IBM CARD FORMAT

	Columns		Columns
Site Number	1 - 3	Cortex Platform	34 - 35
Area	4 - 5	Faceted Platform	36 - 37
Level	6 - 7	Single Platform	38 - 39
Unit	8 - 9	Crushed Platform	40 - 41
Debitage Element	10 - 11	Quad Number*	51 - 52
Total	12 - 15	Feature Number	53 - 55
Whole Pieces	16 - 18		
Proximal Ends	19 - 21	*NW = 1	
Other	22 - 24	NE = 2	
Heat Altered	25 - 27	SE = 3	
Weight	28 - 33	SW = 4	

Data Base

The raw data information for the major sites are provided in the Appendices. The main and extension project non-tool lithic totals by site/area are provided in Tables 14.5-2 through 14.5-4. The per cent of debris (chips/chunks) relative to the area totals are presented in order to demonstrate the high number of artifact frequencies not studied at this piont. It can be seen that, from Table 14.5-5, if all 565,198 pieces of non-tool lithic data were presented, it would encompass an entire volume to itself. These data tables are on file at the Archaeology Laboratory, North Texas State University. Therefore, only selected site information, to save space and funds, are included for this report.

Analysis Procedure

When a homogeneous group of levels occurred, they were placed within brackets to form distinct data cells (Table 14.5-6). This was done without the influence of "named" cultural zones derived from projectile point types or radiocarbon dates. The slope of the deposits, which would have been evident in profile drawings, was also not an influencing factor since no radical sloping was detected in the sites.

After completion of locating all the data cells for each of the sites to be investigated, levels, or a combination of levels, were chosen to be representative of the "named" cultural zones. Tables 14.5-7 and 14.5-8 give the results by site-area-level for each reservoir under their respective cultural headings. A few areas have multiple listings to test where a stronger "fit" might occur due to the low number of diagnostic artifacts within those areas which prevented accurate placement into the cells.

Having created the North Fork and Granger reservoir tables, systematic comparison using Chi-square was begun. The first order of testing was area to area within a site for each cultural zone by reservoir. These results were compared, where possible, with the results from the 1978 field season studies to see if complete area information was a more effective indicator of homogeneity than the partial data cells dealt with during ongoing excavations. The 1978 Chi-square studies and the late 1979 studies give similar results. Only site 41WM56, area B vs. area C for level 6 demonstrated any change from the original findings (homogeneous to heterogeneous). This new information would not have affected the field decisions concerning area B since that area had already achieved homogeneity and no further horizontal or vertical excavations were recommended (Chapter 6.3). As these first order findings are similar to what has already been presented, no duplication of results is provided.

Table 14.5-2.

North Fork Reservoir Non-tool Lithic Totals by Site-Area.

SITE	AREA	NON-TOOL TOTAL	CHIPS/CHUNKS	- %
41WM53	A	14,236	6,612	- 46.45
	B	10,101	5,093	- 50.42
	C	3,843	1,189	- 30.94
		28,180	12,894	- 45.76
41WM56	A	15,954	7,132	- 44.70
	B	19,687	8,669	- 44.03
	C	152,489	73,186	- 47.99
	D	11,192	4,687	- 41.88
	E	20,166	9,631	- 47.76
	F	9,484	5,026	- 53.00
		228,972	108,331	- 47.31
41WM57	A	9,377	3,931	- 41.92
	B	3,011	964	- 32.02
	D	3,056	907	- 29.68
	E	5,982	2,162	- 36.14
	F	1,253	481	- 38.39
	H	3,352	1,195	- 35.65
	I	7,896	4,153	- 52.60
		33,927	13,793	- 40.66

Table 14.5-2: Continued

SITE	AREA	NON-TOOL TOTAL	CHIPS/CHUNKS	-	%
41WM73	A	4,479	2,238	-	49.97
	B	15,364	6,240	-	40.61
	C	3,398	1,635	-	48.12
	D	491	229	-	46.64
	E	1,123	351	-	31.26
		24,855	10,693	-	43.02
41WM304	A	13,484	5,704	-	42.30
	B	7,972	2,854	-	35.80
		21,456	8,558	-	39.89
41WM328	A	5,540	2,702	-	48.77
	B	1,495	662	-	44.28
		7,035	3,364	-	47.82

Table 14.5-3.

Granger Reservoir Non-Tool Lithic Totals By Site-Area.

SITE	AREA	NON-TOOL TOTAL	CHIPS/CHUNKS - %	
41WM122	TP-1	917	392	- 42.75
41WM124	A	11,694	5,851	- 50.03
	B	5,042	2,638	- 52.32
	C	1,497	629	- 42.02
		18,233	9,118	- 50.01
41WM133	XU-5	1,258	426	- 33.86
	XU-6	396	213	- 53.79
		1,654	639	- 38.63
41WM163	A	987	544	- 55.12
	B	4,282	2,128	- 49.70
		5,269	2,672	- 50.71
41WM230	XU-1	4,274	1,883	- 44.06
	XU-2	31	22	- 70.97
	XU-3	35,148	15,591	- 44.36
	XU-5	1,423	610	- 42.87
	XU-7	37	22	- 59.46
	XU-8	84	39	- 46.43
	XU-9	3,628	1,428	- 39.36
		44,625	19,595	- 43.91

Table 14.5-3: Continued

SITE	AREA	NON-TOOL TOTAL	CHIPS/CHUNKS	-	%
41WM258	A	1,655	633	-	38.25
	B	334	105	-	31.44
	C	679	229	-	33.73
		2,688	967	-	35.97
41WM267	A	34,531	16,423	-	47.56
	B	36,914	16,555	-	44.85
	C	1,662	765	-	46.03
	D	22,992*	9,354	-	40.68
		96,099	43,097	-	44.85

TP = Test Pit

* Includes lower zone extension materials.

Table 14.5-4.

San Gabriel Extension Non-Tool Lithic Totals By Reservoir - Site - Area.

North Fork

SITE	AREA	NON-TOOL TOTAL	CHIPS/CHUNKS - %
41WM61	Surface	132	5 - 3.79
41WM65	Surface	1,253	473 - 37.75
41WM71	Surface	80	5 - 6.25
41WM328	N/S	73	19 - 26.03
41WM360	Surface	4,199	1,191 - 28.36
41WM371	Surface	278	94 - 33.81
41WM402	Surface	1,069	595 - 55.66
41WM404	A	21,478	7,343 - 34.19
41WM419	TP-1	235	120 - 51.06

Granger

SITE	AREA	NON-TOOL TOTAL	CHIPS/CHUNKS - %
41WM117	E/W	508	67 - 13.19
	N/S	503	111 - 22.07
		1,011	178 - 17.61
41WM126	Surface	40	1 - 2.50
	TP-1	4,406	2,365 - 53.68
	TP-2	2,275	984 - 43.25
	TP-3	5,651	2,858 - 50.58
	TP-4	45	14 - 31.11

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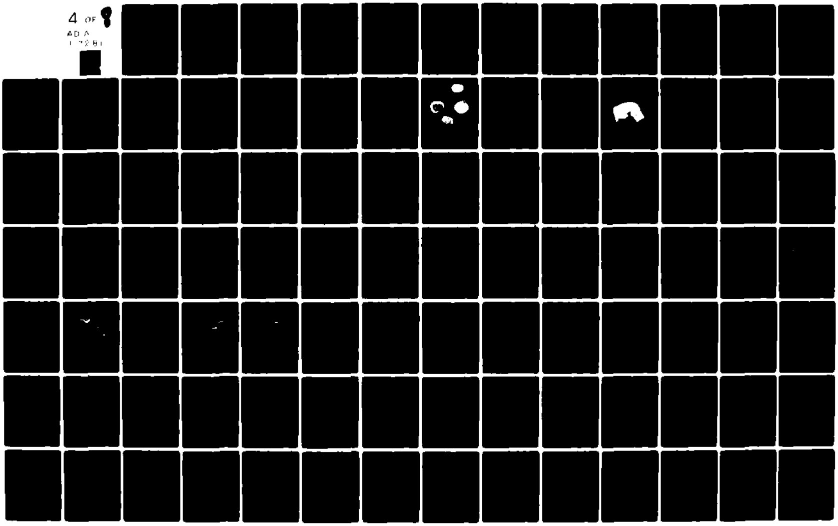

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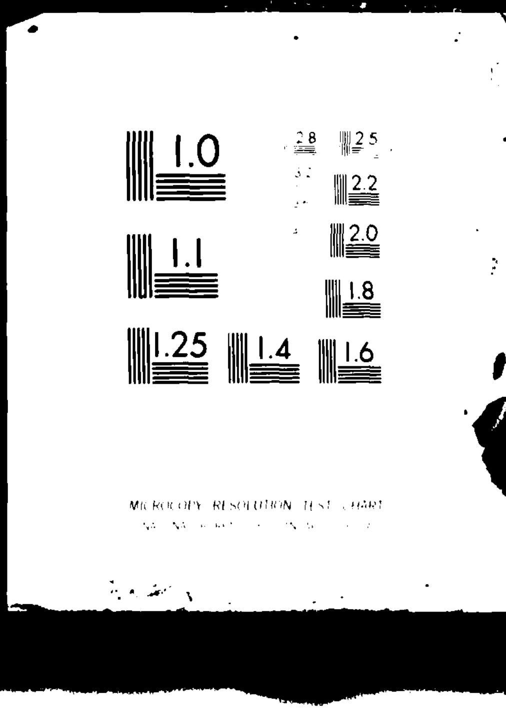


Table 14.5-4: Continued

Granger (Continued)

SITE	AREA	NON-TOOL TOTAL	CHIPS/CHUNKS	-	%
	TP-5	4,532	2,257	-	49.80
	TP-6	1,053	450	-	42.74
	N/S(West)	470	89	-	18.94
	E/W Line	124	14	-	11.29
	N/S Line	173	21	-	12.14
		18,769	9,053	-	48.23
41WM134	N/S	1,375	256	-	18.62
	E/W	1,176	220	-	18.71
		2,551	476	-	18.66
41WM318	Surface	67	18	-	26.87
41WM323	Surface	68	9	-	13.24
41WM412	Surface	25	13	-	52.00

TP = Test Pit

E/W and N/S = Surface Transect

Table 14.5-5. San Gabriel Project Non-Tool Lithic Grand Totals.

		NON-TOOLS	CHIPS/CHUNKS	-	%
North Fork Reservoir	=	344,425	157,633	-	45.77
Granger Reservoir	=	169,485	76,480	-	45.13
North Fork Extension	=	28,797	9,845	-	34.19
Granger Extension	=	22,491	9,747	-	43.34
PROJECT TOTALS	=	565,198	253,705	-	44.89

Table 14.5-6

41WM328, Area A Debitage Totals by Level with Homogeneous Brackets

DEBITAGE	1	(2	3	4)	5	6	7
$1^{o} + 2^{o}$ a	6	15	11	9	10	3	-
2^{o} b	22	71	55	34	31	5	-
TF	205	354	304	276	100	44	9
MF	181	306	314	237	122	32	5
BTF	2	16	10	5	4	-	-

41WM328, Area A, Chi-Square Values (.05) Used to Create the Above Table

LEVEL	X^2	df	$P(X^2)$	HOMOGENEOUS
1 → 2	7.03	3	.929	?
2 → 3	3.87	3	.724	Yes
3 → 4	4.10	3	.749	Yes
4 → 5	16.73	3	.998	No
3 → 5	8.91	3	.969	No
2 → 3 → 4	8.83	6	.816	Yes

Table 14.5-7.

North Fork Reservoir Site-Area-Level Units by Cultural Zone.

SITE	TOYAH	AUSTIN	TWIN SISTER	SAN MARCOS	ROUND ROCK	CLEAR FORK	SAN GERONIMO	CIRCLE-VILLE	PALEO-INDIAN
41WM53		A 1-3 B 3-5	A 6-8 B 3-5 C 6-8						
41WM56			A 1-2		D 7- 9	B 6-10 C 6- 7 D 7- 9 E 5- 7	A 7- 8 C 10-12 E 5- 7		
41WM57				B 3-4 D 3-4 F 4-5	E 2- 3	E 4- 5			
41WM73				A 1-3	A 6- 7 B 10-15 C 2- 5 D 1- 4 E 7-10	B 16-17 B 18-19			
41WM304					A 1- 4	A 5- 8 B 2- 5 B 6- 8			
41WM328		B 8-10	A 2- 4 B 15-17						
OTHER				41WM404	41WM404	41WM404		41WM419	41WM419

Table 14.5-8.

Granger Reservoir Site-Area-Level Units by Cultural Zone.

SITE	TOYAH	AUSTIN	TWIN SISTER	SAN MARCOS	ROUND ROCK	CLEAR FORK	SAN GERONIMO	CIRCLE-VILLE	PALEO-INDIAN
41WM124		B 3-14	A 6-10 B 3-14	A 21-36 B 15-20		C 2- 5			
41WM163	A 2-4	A 2- 4 B 1- 2	A 5- 8 B 3- 8	A 9-14 B 9-10	B 12-14				
41WM230	XU3 2-7	XU3 2- 7	XU3 8-10 XU5 5-10	XU3 11-33	XU3 34-39 XU9 7-10				
41WM258	A 3-5	A 6- 7 B 6-10	C 5- 6						
41WM267			B 5- 9 B 11-14	A 2-13 B 5- 9 B 11-14		A 14-16 A 17-19 B 15-18 C 6-13	D 65-74		
OTHER					41WM122			41WM133	

The second order to testing was site to site for each cultural zone by reservoir using the individual areas of each site. Homogeneous sites by reservoir with their Chi-square values are presented in Table 14.5-9 and 14.5-10. Starting with the Clear Fork Phase in the North Fork Reservoir, areas of all four sites represented were similar in their debitage distributions. However, fewer sites are homogeneous as one progresses from the Round Rock through the Austin Phase. These similarities are pictured in Figure 14.5-1.

In the Granger reservoir, again starting with the Clear Fork Phase, debitage distribution similarities occur from the Round Rock through the Toyah time periods with the San Marcos Phase having the most inter-site homogeneity (Figure 14.5-2). It is not readily apparent why these sites have similar (or dissimilar) debitage frequencies. A general explanatory attempt is made after the inter-reservoir comparisons which follow.

The final order of testing was an inter-reservoir comparison by cultural time period. Figure 14.5-3 pictures these periods with representative sites chosen from the intra-reservoir list based on their heterogeneity and more accurate diagnostics. This would allow a variety of dissimilar sites to be cross tested while saving time and effort by not testing similar sites from the intra-reservoir list. Intra-reservoir homogeneity for the sites given is shown with the outside arrows while inter-reservoir homogeneity is depicted with cross-cutting arrows. The San Marcos phase again contains the most similarities of debitage distributions. Chi-square values for these inter-reservoir comparisons are provided in Table 14.5-11.

Results of Analysis

At this point the results of the inter-reservoir comparisons are presented. These data are only part of the information used for the interpretations found in the final conclusions at the end of this report. Therefore, only a limited attempt is possible in this section to see if debitage frequencies can be useful in site interpretation.

Referring to Figure 14.5-3, heterogeneity for the Circleville and the San Geronimo Phases may be attributed to the smallness of the sample sizes, especially at site 41WM133. This lack of data would automatically prohibit homogeneous results from occurring. Additional excavations would provide the necessary information needed for Chi-square comparisons between these sites.

The Clear Fork projectile points are different between the reservoirs (Chapter 14.2) and at 41WM267, a few types are present which are not found in the North Fork Reservoir at all. The lithic reduction sequence implemented to produce these points and other tools may be

Table 14.5-9.

North Fork Reservoir Homogeneous Sites with Debitage Chi-Square Values (.05) by Cultural Zone. Critical Values of df for 2 = 5.99, 3 = 7.82

CULTURAL ZONE	SITE-AREA	X^2	df	$P(X^2)$
AUSTIN	53A ↔ 328B	1.49	2	.479
TWIN SISTER	328B ↔ 56A	2.68	3	.447
	53C ↔ 56A	6.38*	2	.959
	53C ↔ 328B	5.49	2	.937
SAN MARCOS	73A ↔ 57B	7.46*	3	.942
ROUND ROCK	57E ↔ 304A	1.54	3	.323
CLEAR FORK	73B ↔ 56D	5.09	3	.836
	304A ↔ 57E	4.20	3	.760
	57E ↔ 56E	5.32	3	.851
	304A ↔ 56E	1.99	3	.423

*Heterogeneous?

Table 14.5-10.

Granger Reservoir Homogeneous Sites with Debitage Chi-Square Values by Cultural Zone. Critical Value for 3 df = 7.82

CULTURAL ZONE	SITE-AREA-LEVEL	X^2	df	$P(X^2)$
TOYAH	163A ↔258A	7.65*	3	.947
AUSTIN	124B ↔258B	2.11	3	.447
	258B ↔163A	4.04	3	.744
	163A ↔258A	.27	3	.036
TWIN SISTER	258C ↔163B	3.75	3	.710
	163B ↔267B 11-14	7.31	3	.938
SAN MARCOS	230XU3 ↔163A	3.57	3	.688
	230XU3 ↔124A	5.56	3	.866
	267A ↔163A	2.12	3	.449
	267A ↔124A	2.51	3	.477
	267B 11-14↔124A	.73	3	.134
	267B 11-14↔163A	2.31	3	.485
	163A ↔124A	2.17	3	.459
	267B 5-8 ↔163A	3.07	3	.618
ROUND ROCK	122 ↔230XU3 35-38	6.35	3	.905
	122 ↔230XU9 7-10	5.67	3	.872

*Heterogeneous?

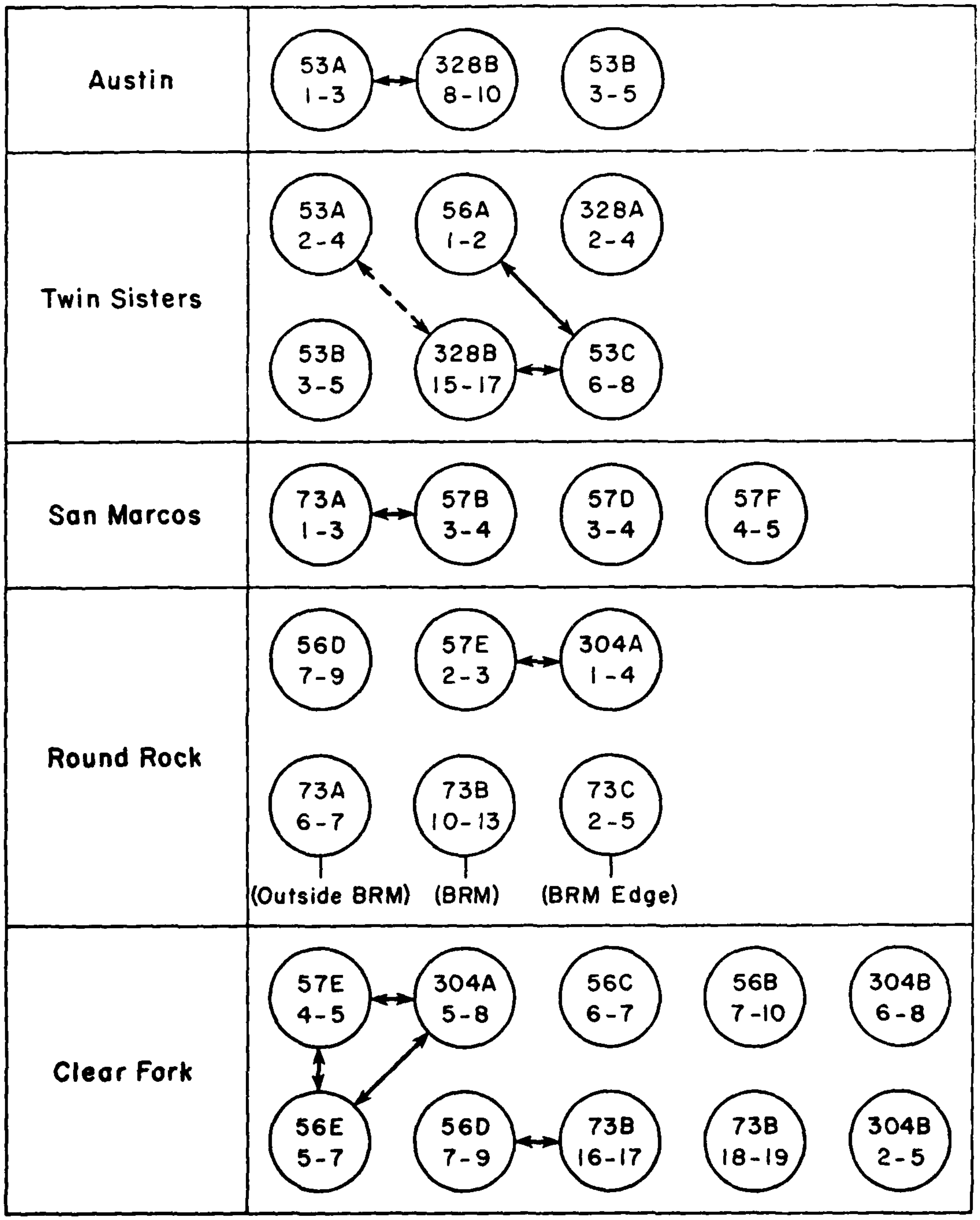


Figure 14.5-1. North Fork Chi-Square Analysis Results

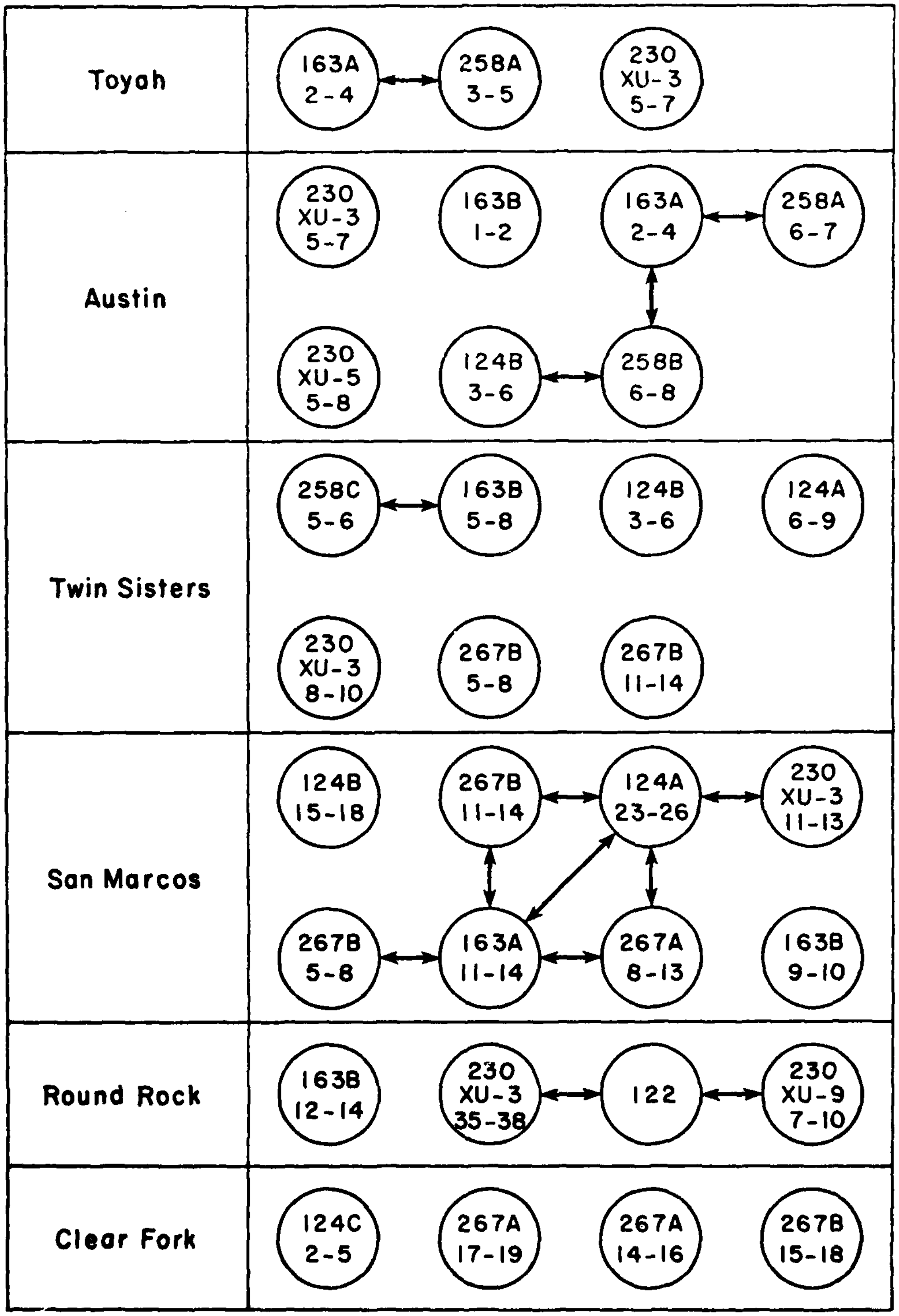


Figure 14.5-2. Granger Chi-Square Analysis Results

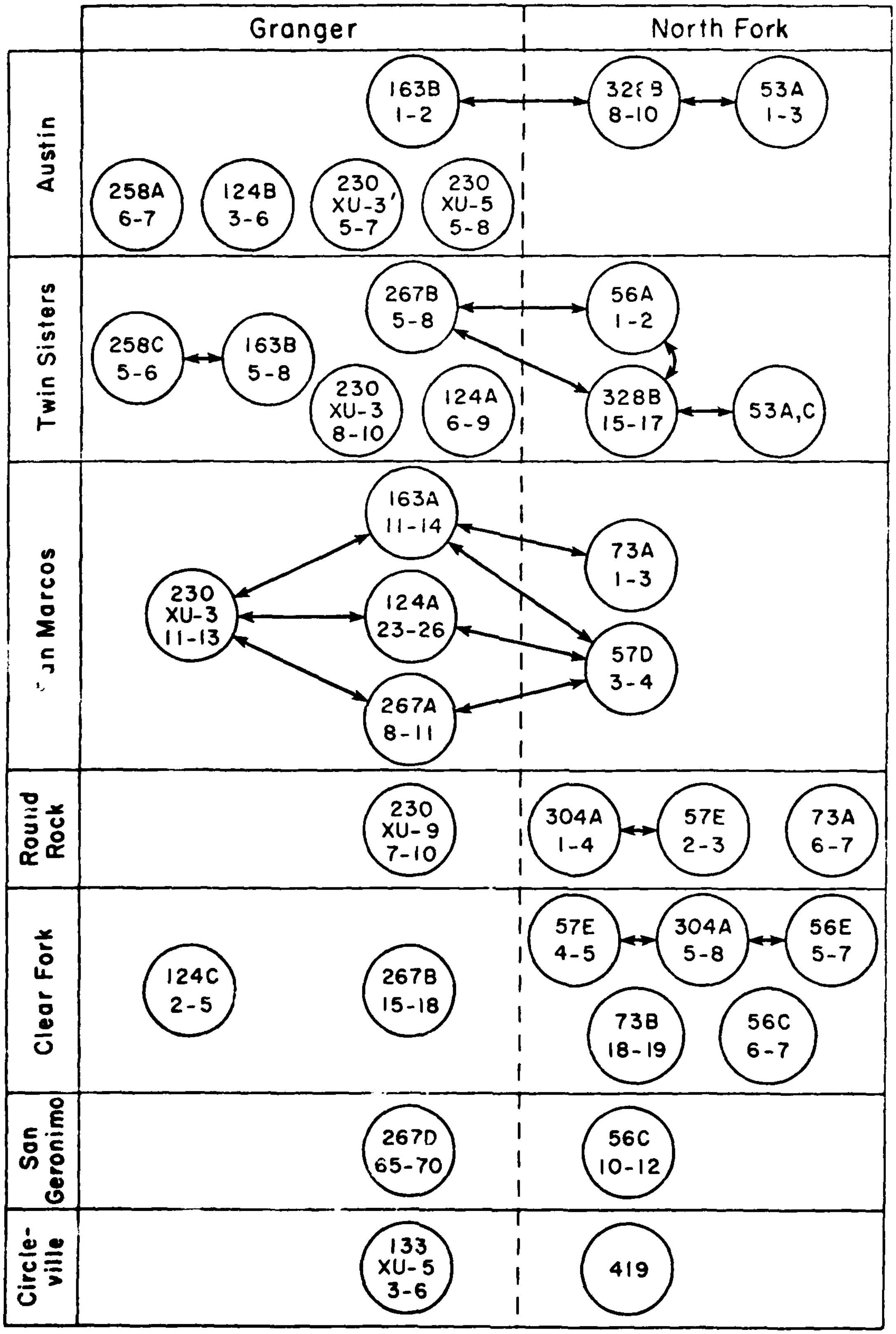


Figure 14.5-3. Inter-Reservoir Comparisons of Debitage Chi-Square Analysis.

Table 14.5-11.

Inter-Reservoir Homogeneous Sites with Debitage Chi-Square Values by Cultural Zone. Critical Value for 3df = 7.82

CULTURAL ZONE	SITE-AREA-LEVEL GRANGER ↔ NORTH FORK	X^2	df	$P(X^2)$
AUSTIN	163B 1- 2 ↔ 328B 8-10	5.29	3	.849
TWIN SISTERS	267B 5- 8 ↔ 56A 1- 2	2.55	3	.469
	267B 5- 8 ↔ 328B 15-17	2.64	3	.453
SAN MARCOS	163A 11-14 ↔ 73A 1- 3	4.73	3	.809
	163A 11-14 ↔ 57D 3- 4	1.02	3	.200
	124A 23-26 ↔ 57D 3- 4	6.27	3	.902
	267A 8-11 ↔ 57D 3- 4	3.41	3	.667

reflected in the debitage frequencies present. That type of relationship, if one can be discerned, would comprise an entire research project all its own and would require controlled debitage analysis more rigorous than provided for on this project. No clear reason for the inter-reservoir heterogeneity is apparent, at this time, for the Clear Fork Phase.

Debitage heterogeneity in the Round Rock Phase may be attributed to the functions of the sites tested. The North Fork sites are burned rock middens while the Granger site (41WM230, XU-9) is an alluvial terrace situation. The frequencies present reflect the type of sample recovered and the Chi-square results are not necessarily a statement that the sites are not homogeneous.

The San Marcos Phase has a sampling problem in the North Fork in that most of the information is found in zones determined to be of a mixed nature, either due to plowing or disturbance from local artifact collectors, and were not used in the debitage Chi-square studies. Thus, sites that were used are limited to 41WM57 and 41WM73. It is interesting to note that, like in the Round Rock Phase, the site types are the same (alluvial to BRM's) yet homogeneity is apparent. Perhaps site function alone is too broad a factor in considering site similarities.

Lastly, the Twin Sisters and Austin Phase results are not readily understood. The sites represent open terrace situations whose features are similar in that they are non-descriptive flat clusters of burned rock. Heterogeneity must be related to factors whose characteristics were not controlled for in the sampling methodology.

Another consideration in interpreting these results may lie in the strict adherance to the .05 level of significance. Since more homogeneity would be present if this limit were changed to .01 or .001, perhaps a reevaluation of the Chi-square research design is in order.

Conclusions

Suggestions for future projects include the use of a few complimentary statistics to Chi-square that utilize a broader range of debitage categories, especially those with low frequencies, for their data base. As a measurement of association, on an ordinal scale, between two data sets, Spearman's or Kendall's Rank Correlation Coefficients could be employed. If several data sets need investigating, Kendall's Coefficient of Concordance might apply. Lastly, using the same data set as Chi-square, Kendall's Tau-B would not only test for homogeneity between data sets, or assemblages such as debitage, but would also test the "independence" of the information. In a field laboratory situation, the data base for these statistics would be easily obtainable from the lithic analysis forms.

Suggestions for post field season debitage investigations include closer controls on projected experimental designs to ensure precision and efficiency in the experiment, the proper use and interpretation of significance testing and a needed adherance to statistical power (Stafford and Stafford, 1979). Emphasis should also be directed more towards measurement of continuous variables, rather than just frequencies, as a possible means of investigating technological change. These variables may have to go beyond the traditional length, width, shape, platform type and angle studies of the past.

Although the region and time period under study is different, a recent methodological approach to test for technological variability on an intra-assemblage level, using cores and debitage, could be applied to the San Gabriel data base (Ferring, 1979). Considerations of the mechanics of lithic reduction, as well as cultural factors, were studied using a one-way analysis of variance (ANOVA) as the primary statistical approach. Reduction strategies were defined and significant patterns of intra-assemblage variability were illustrated using a variety of observed and measured variables. To a limited degree, the flake shape analysis (Chapter 14.4) of this report is a similar approach to the above ANOVA design.

14.6 Pecked and Ground Stone, Hammerstones, and Cores

by

Duane E. Peter and Marie-Anne Demuynck

Introduction

Seventy-seven pecked and ground stone artifacts were recovered from the eighteen sites investigated during the last two phases of archaeological work at the North Fork and Granger Lake Reservoirs. Ten manuports were also recovered. Of this total (87), only 24 artifacts were recovered from sites within the Granger Reservoir; the remaining 63 are from sites in the North Fork Reservoir. This difference in quantity merely reflects the greater volume of site matrix removed in the North Fork Reservoir rather than a differential patterning of utilization of ground stone tools.

The ground stone artifacts consist of complete and fragmentary manos, grinding slabs, anvils, mortars, and composite mano/anvils and mano/hammerstones. Most of these artifacts are of materials which are not commonly found along the San Gabriel River drainage. A very few of these specimens are made of flint (2) or limestone (8) which are readily obtained within the drainage. The remainder of these artifacts are made of quartzite (24), vein quartz (18), sandstone (20), and granite (6). Unmodified cobbles of these non-local raw materials have been classified as manuports.

North Fork Reservoir

Sixty-three ground stone artifacts and manuports were recovered from ten sites investigated at the North Fork Reservoir (Table 14.6-1). Thirty-six of these specimens are from proveniences which can be assigned to a specific culture/time stratigraphic unit. Ground stone tools are represented throughout the cultural sequence within the North Fork Reservoir. The small quantities in the Late Archaic and Neo-American phases reflect the smaller volume of primary deposits excavated for these phases rather than an actual decline in the utilization of ground stone artifacts. It is apparent, however, that wherever the Round Rock stratigraphic unit was adequately sampled, ground stone artifacts were quite numerous.

Manos

Seven complete and twenty fragmentary manos were recovered from the North Fork Reservoir sites. The morphology of these specimens is oval in outline with a lenticular cross-section formed by parallel, flat grinding surfaces. Biconvex cross-sections are also well represented. Except for two specimens, all exhibit two ground surfaces. The shape of these artifacts

14-300

TABLE 14.6-1. Provenience and Characteristics of Ground Stone Artifacts and Manuports Recovered from Sites Within the North Fork Reservoir.

ARTIFACT TYPE	AREA	UNIT	LEVEL	CULTURE/TIME Stratigraphic Unit	RAW MATERIAL	DIMENSIONS (cm)
			SITE 41WM53			
Mano Fragment	C	N101/W118	2	Unknown	Quartzite	3.5 x 3.5 x 1.5
			SITE 41WM56			
Grinding Slab Fragment	A	N1026/W1093	4	San Marcos/ Round Rock	Sandstone	14 x 12.5 x 3
Grinding Slab Fragment	A	N1027/W1094	4	San Marcos/ Round Rock	Sandstone	10 x 9.5 x 3
Mano Fragment	A	1027/ W1093	6	San Geronimo	Granite	5 x 5.5 x 4
Mano/Hammer-stone	B	N1042/W1106	4	Round Rock	Quartz	
Grinding Slab Fragment	B	N1042/W1105	7	Clear Fork	Sandstone	12.5 x 6.5 x 2.5
Mano	B	N1042/W1106	10	Clear Fork	Quartzite	11.5 x 7.5 x 3
Mano	C	N1063/W1098	2	Unknown	Sandstone	12 x 7.5 x 6
Abrading Stone	C	N1061/W1100	3	Unknown	Limestone	Irregular Cobble
Manuport	C	N1063/W1097	4	Unknown	Sandstone	14 x 10 x 5.5
Mano Fragment	C	N1064/W1100	5	Round Rock	Granite	4.5 x 11 x 5
Mano Fragment	C	N1060/W1100	6	Clear Fork	Quartz	5.5 x 4.5 x 3
Grinding Slab	C	N1064/W1097	6	Clear Fork	Quartzite	22.5 x 28 x 4.5
Mano/Anvil	C	N1060/W1099	8	Clear Fork	Quartzite	10 x 8 x 4.5
Mano/Anvil	C	N1060/W1099	8	Clear Fork	Quartz	10 x 9.5 x 6
Mano Fragment	C	N1061/W1097	10	San Geronimo	Granite	7 x 6 x 4
Mano/Hammer-stone	D	N1049/W1111	Surface	Austin/Toyah	Quartz	11.5 x 8 x 4.5
Grinding Slab Fragment	D	N1050/W1111	3	Austin/Toyah	Sandstone	9 x 6.5 x 2
Grinding Slab Fragment	D	N1049/W1111	4	San Marcos/ Round Rock	Quartzite	7.5 x 7 x 1.5
Mano Fragment	F	N1047/W969	1	Twin Sisters	Sandstone	7.5 x 3.5 x 3
Manuport	F	N1047/W969	1	Twin Sisters	Sandstone	4.5 x 3 x .5

Table 14.6-1. Continued

14-301

ARTIFACT TYPE	AREA	UNIT	LEVEL	CULTURE/TIME Stratigraphic Unit	RAW MATERIAL	DIMENSIONS (cm)
Mano	BHT 1	BHT 1	100.385 m	Unknown	Sandstone	12 x 8 x 3.5
Grinding Slab Fragment	BHT 1	Profile 3	100.89 m	Unknown	Sandstone	8 x 7.5 x 3
Mano/Hammer-stone		BHT 1		Unknown	Quartz	9 x 7.5 x 5.5
Mano/Anvil		BHT 4		Unknown	Quartz	11 x 9.5 x 4
Mano Fragment		BHT		Unknown	Sandstone	5.5 x 9 x 4.5
Mano/Hammer-stone		BHT		Unknown	Quartz	9 x 7 x 4.5
				SITE 41WM57		
Mano Fragment	A	N1028/W1007	2	Unknown	Quartzite	6.5 x 4 x 6
Mano Fragment	A	N1030/W1014	4	San Marcos/ Round Rock	Sandstone	7 x 3 x 3.5
Grinding Slab	D	N1015/W1064	2	Unknown	Quartzite	38 x 29 x 4
Mano/Anvil	F	N1022/W1000	6	San Marcos/ Round Rock	Quartz	14 x 9 x 6
Mano Fragment	I	N1099/W1061	1	Unknown	Granite	6.5 x 5.5 x 4.5
Mano	BHT			Unknown	Quartz	12.5 x 9 x 6
				SITE 41WM61		
Grinding Slab Fragment		Surface		Unknown	Quartzite	19 x 15.5 x 1.5
Mano/ Hammerstone		Surface		Unknown	Quartz	10.5 x 6.5 x 3
				SITE 41WM65		
Grinding Slab Fragment		Surface		Unknown	Quartzite	8 x 5 x 2
Mano		East Transect		Unknown	Quartzitic Sandstone	
				SITE 41WM73		
Manuport	B	N1041/W1051	9	Round Rock	Quartz	15 x 8.5 x 8
Mano Fragment	B	N1041/W1051	10	Round Rock	Quartz	5 x 3 x 1.5
Mano Fragment	B	N1041/W1051	10	Round Rock	Sandstone	5 x 9 x 5.5

14-302

Table 14.6-1. Continued.

ARTIFACT TYPE	AREA	UNIT	LEVEL	CULTURE/TIME Stratigraphic Unit	RAW MATERIAL	DIMENSIONS (cm)
Manuport	B	N1041/W1051	13	Round Rock	Red Quartzite	7 x 6 x 3
Mano Fragment	B	N1041/W1050	13	Round Rock	Quartz	7 x 3 x 3.5
Anvil (?)	B	N1040/W1048	14	Round Rock	Limestone	17 x 16 x 5
Manuport	B	N1041/W1048	17	Round Rock/ Clear Fork	Quartz	5 x 4.5 x 1.5
Manuport	B	N1040/W1051	18	Clear Fork	Quartz	4 x 7 x 4.5
Mano Fragment	B	N1040/W1049	18	Clear Fork	Quartzite	5 x 6 x 3
Mano Fragment	C	N1038/W1034	5	Round Rock	Granite	9.5 x 9.5 x 7
Mano	E	N1033/W1045	3	Round Rock	Flint	8.5 x 8 x 6.5
Grinding Slab	BHT 1			Round Rock	Quartzite	23 x 17 x 6

SITE 41WM304

ARTIFACT TYPE	AREA	UNIT	LEVEL	CULTURE/TIME Stratigraphic Unit	RAW MATERIAL	DIMENSIONS (cm)
Manuport	A	N107/W99	7	Clear Fork	Quartzite	5 x 5 x 3.5
Mortar	A	N107/W99	8	Clear Fork	Limestone	12 x 12 x 11

SITE 41WM328

ARTIFACT TYPE	AREA	UNIT	LEVEL	CULTURE/TIME Stratigraphic Unit	RAW MATERIAL	DIMENSIONS (cm)
Mano/Anvil	A	N1000/W1011	3	Twin Sisters	Granite	9 x 7.5 x 3.5
Mano Fragment	A	N998/W1011	3	Twin Sisters	Sandstone	8.5 x 8.0 x 4
Anvil (?)	B	N982/W1002	16	Twin Sisters	Limestone	16.5 x 10.5 x 5
Mano		Surface		Unknown	Quartzite	14 x 6.5 x 5

SITE 41WM360

ARTIFACT TYPE	AREA	UNIT	LEVEL	CULTURE/TIME Stratigraphic Unit	RAW MATERIAL	DIMENSIONS (cm)
Grinding Slab Fragment		East Transect		Unknown	Sandstone	10 x 8 x 2
Mano Fragment		East Transect		Unknown	Sandstone	6 x 4.5 x 3
Mano Fragment		Surface		Unknown	Quartzite	6.5 x 10 x 5.5
Mano Fragment		Surface		Unknown	Quartzite	7.5 x 10 x 6
Mano Fragment		Surface		Unknown	Sandstone	10 x 9.5 x 5.5

SITE 41WM404

ARTIFACT TYPE	AREA	UNIT	LEVEL	CULTURE/TIME Stratigraphic Unit	RAW MATERIAL	DIMENSIONS (cm)
Grinding Slab Fragment		N100/W100	8	Archaic	Limestone	14 x 13.5 x 7
Anvil (?)		Surface		Austin/Toyah	Limestone	
Anvil (?)		Surface		Austin/Toyah	Limestone	7 x 7 x 4.5

changes very little through time.

Quartzite (n=6), vein quartz (n=4), granite (n=6), sandstone (n=10), and flint (n=1) comprise the raw materials used for the production of manos. The predominance of sandstone may be partially related to the greater ease in shaping it rather than the other raw materials. Perhaps, the most interesting specimen is a naturally fractured flint cobble which has a single ground surface.

Mano/Anvil

Five ground stone specimens were used as both manos and anvils. The designation, "anvil", refers to the presence of small (5cm in diameter) battered or pecked depressions on one or more surfaces of the specimen. Morphology of these specimens is more variable than that of the manos. One specimen has a twisted cross-section (Figure 14.6-1a) due to the utilization of small surface areas at opposite corners. Although one side was utilized more intensively, both surfaces exhibit the same patterns of use. A battered depression is present in the center of each surface. Another specimen (Figure 14.6-1b) is wedge-shaped. One surface has a battered depression. The remaining specimens have the common oval outline of the manos with one or both surfaces exhibiting battered depressions.

The raw materials for these artifacts are granite (n=1), vein quartz (n=3), and quartzite (n=1). The additional use of these manos as anvils likely required these harder substances. Sandstone would not have withstood the impact forces directed upon an anvil surface.

Mano/Hammerstone

Five manos were also used as hammerstones. Each has one or two ground surfaces with battered ends or edges. One specimen also shows gentle, linear depressions across both ground surfaces. The depressions have the same degree of grinding as the remainder of the ground surface.

The need for a hard substance for use as a hammerstone is reflected in the raw material chosen for these specimens. All five are made of vein quartz. The large number of fragmentary manos may reflect the inability of the other raw materials to withstand the stress of use as hammerstones. It is highly unlikely that manos were fragmented due to their utilization for grinding nuts, seeds, and other vegetable matter.

Grinding Slabs

Three complete and ten fragmentary grinding slabs were recovered from the sites investigated within the North Fork Reservoir. The morphology of these specimens is quite variable. The blanks for grinding slabs were apparently irregular shaped slabs of rock which were not significantly

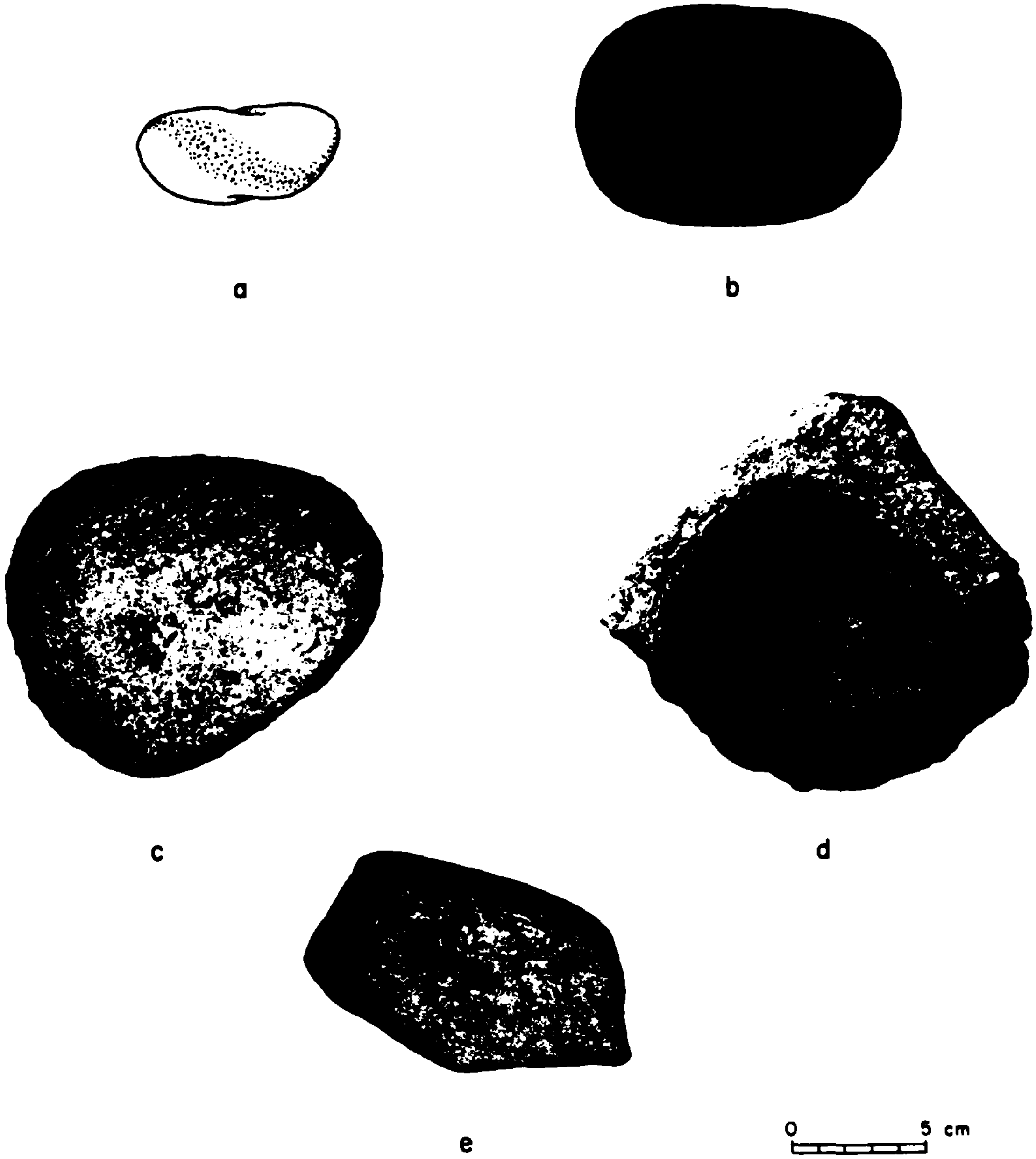


Figure 14.6-1. Photograph of Ground Stone Artifacts from North Fork and Granger Reservoirs.

a. Mano/Anvil - Site 41WM328
b. Mano/Anvil - Bigon-Kubala Site (41WM258)
c. Anvil (?) - Site 41WM404
d. Mortar - Site 41WM304
e. Abrading Stone - Hawes Site (41WM56)

altered for use. The grinding depressions usually involve the entire surface of the slab. In some cases, both surfaces were utilized. The grinding depressions are usually quite shallow (1.5 to 2.0 cm). The raw materials selected for grinding slabs were sandstone (n=6), quartzite (n=6), and limestone (n=1).

Anvils

Four limestone artifacts from sites 41WM328, 41WM73, and 41WM404 have been recognized as probable anvils. Each specimen has single or multiple depressions on its surface. The specimen from site 41WM328 has a single, circular depression (1.5 cm in diameter) in the center of one surface. The specimen from site 41WM73 exhibits a similar depression (1.75 cm in diameter) in the center of a pecked surface (11cm in diameter). One of the specimens from site 41WM404 was fractured at the center of a circular depression on its surface.

The remaining specimen from site 41WM404 (Figure 14.6-1) is distinguished by the presence of two circular depressions on both sides of the limestone slab. These depressions are consistently 1.8 cm. in diameter and .8 to 1.0 cm. apart. The uniformity of these circular depressions suggests that the term, "anvil", may not be appropriate. The nature of the depressions on all of these artifacts is very different from the battered depressions noted on several of the mano/anvils. Perhaps, these depressions served as sockets for a rotating stick rather than as a point of impact. If these artifacts were used as anvils, the force of impact was necessarily small to avoid fracturing the soft limestone.

Mortar

One mortar (Figure 14.6-1d) was recovered from site 41WM304 from a Clear Fork stratigraphic unit. This specimen is made of an irregular shaped limestone block. The mortar depression is 9 cm. in diameter and 3.5 cm. in depth. The interior of the depression is not well ground, but it is significantly smoother than the surrounding surfaces.

Abrading Stone

A single irregular shaped, limestone cobble recovered from the Hawes Site (41WM56) may have been used as an abrading stone (Figure 14.6-1e). Five grooves, approximately 3 cm. in length and v-shaped in cross-section, appear on one surface of the cobble. The cross-section of these grooves indicates that the edge of a biface or other lithic artifact may have been roughened or abraded with the use of this artifact.

Manuports

Four complete and three fragmentary cobbles of non-local raw material were recovered. Vein quartz (n=3), quartzite (n=2), and sandstone (n=2) cobbles comprise this category. None of these specimens exhibited any modification by grinding or pecking; however, they were likely carried to these sites as raw material for the production of ground stone tools.

Granger Reservoir

Investigation of eight sites from the Granger Reservoir District yielded twenty-four ground stone artifacts and manuports. Only thirteen of these are from proveniences which can be assigned to a particular stratigraphic unit. Given the larger volume of matrix removed from the Clear Fork and San Geronimo levels, the number of ground stone tools is relatively small. It appears that the utilization of ground stone tools was not very important during the Early Archaic periods. The lack of an adequate sample of the Round Rock stratigraphic unit at these sites precludes any comparisons with the samples from the North Fork Reservoir.

Manos

The Granger Reservoir sites yielded two complete and four fragmentary manos. Four of these specimens were made of quartzite; the remaining two were of vein quartz. Like the specimens from the North Fork Reservoir, these specimens have an oval outline with a biconvex cross-section (Fig. 14.6-2a). The working surfaces of these manos do not reflect equal use as grinding surfaces. One fragment from site 41WM125 also has linear depressions which may be the result of abrading functions.

Mano/Hammerstones

Three of the ground stone artifacts served dual purposes as manos and hammerstones. These typically oval shaped manos with convex grinding surfaces have one or more battered edges. Only one end of the specimen from site 41WM126 had been used as a hammer. Both ends of the mano from site 41WM134 were battered from use as a hammerstone. The remaining specimen, from site 41WM162, shows evidence of utilization as a hammerstone on all edges. Like the North Fork Reservoir specimens, these mano/hammerstones are made of the more durable raw materials: vein quartz (n=2) and quartzite (n=1).

Grinding Slabs

Two complete and one reconstructed grinding slab (Fig. 14.6-2b) were recovered from the excavation at the Cervenka Site (41WM267). The remainder of the

Figure 14.6-2. Photograph of Fragmented Grinding Slab from the Cervenka Site (41WM267).

grinding slabs recovered from the Granger Lake Reservoir sites consist of eight fragmentary pieces. Sandstone (n=4), quartzite (n=4), vein quartz (n=1), flint (n=1), and limestone (n=1) comprise the raw materials for these artifacts.

The grinding slabs from these sites exhibit considerable variability in the amount of use wear. Of the slabs recovered from the Cervenka Site (41WM267), only one displayed use wear on both surfaces. The pecked and ground depression on one surface covers approximately 98 percent of the surface area. On the opposite side the outer 4-5 cm. of the surface area are unaltered. Of the remaining two slabs, one has a small (16 x 22 cm.) pecked and ground depression on one surface only. Ninety-five percent of one surface of the other specimen has been altered.

Of the eight fragmentary grinding slabs, only two exhibit use wear on both surfaces. Three others show evidence of grinding, but no depression is present. The limestone fragment from site 41WM124 and the sandstone fragment from site 41WM267 are deteriorated from heat alteration and weathering, respectively. The presence of the characteristic depression is the only indication that they were used as grinding slabs. The remaining specimen is unique as a 15 cm. wide, linear or trough-like depression is present on one surface. Like the other specimens this depression is approximately 1.5 cm. in depth. The slabs of raw material for these ground stone artifacts are consistently 2.5 to 6.0 cm. thick.

Manuports

Only three specimens of non-local raw material were recovered from the Granger Lake Reservoir sites. Two are oval shaped quartzite cobble. Their small size suggests that their anticipated use may have been that of hammerstones. The larger cobble of quartzite is also unmodified. Its size (Table 14.6-2) would have been suited for the production of a mano.

Inter-assemblage Comparisons

From a diachronic perspective the ground stone assemblages of both the North Fork and Granger Lake Reservoir sites are remarkably consistent. No stylistic or functional changes are apparent. In fact, except for the initial shaping of the manos, very little formal shaping prior to actual use is perceptible. The ground stone assemblages of particular time periods are, therefore, nondistinctive and of little aid to the definition of cultural phases within Central Texas (Tables 14.6-3 and 4).

Synchronic comparisons of the assemblages from both reservoirs are hindered by the differential volumes of matrix recovered from the respective stratigraphic units. The only noticeable patterns are in the Early Archaic levels where ground stone tools are well represented in the North Fork assemblages, but not in the Granger Lake assemblages. Unfortunately,

TABLE 14.6-2.

Provenience and Characteristics of Ground Stone Artifacts and Manuports Recovered from Sites Within the Granger Reservoir.

ARTIFACT TYPE	AREA	UNIT	LEVEL	CULTURE/TIME Stratigraphic Unit	RAW MATERIAL	DIMENSIONS (cm)
			SITE 41WM124			
Grinding Slab Fragment	A	N801/W804	10	Twin Sisters (?)	Quartzite	8 x 7 x 2.5
Grinding Slab Fragment	A	N801/W803	10	Twin Sisters (?)	Limestone	11 x 9.5 x 3.5
			SITE 41WM125			
Mano Fragment		Surface		Unknown	Quartz	5.5 x 6 x 4
Grinding Slab Fragment		Surface		Unknown	Quartzite	9 x 8 x 4
			SITE 41WM126			
Mano Fragment		Test Pit 1	1	Twin Sisters	Quartz	4.5 x 8 x 2.5
Grinding Slab Fragment		Test Pit 1	5	Twin Sisters	Sandstone	13.5 x 15 x 2.5
Mano/Hammerstone		Test Pit 6	4	Twin Sisters	Quartz	12.5 x 9 x 6
			SITE 41WM134			
Mano/Hammerstone		Surface		Unknown	Quartzite	9 x 5.5 x 3
Mano Fragemnt		Surface		Unknown	Quartzite	8 x 6 x 3
			SITE 41WM163			
Manuport	B	N999/W1056	2	Austin/Toyah	Quartz	8 x 6 x 4
Mano/Hammerstone		Surface		Unknown	Quartz	10.5 x 8.5 x 3.5
			SITE 41WM258			
Mano	C	N975/W973	2	Austin/Toyah	Quartzite	11.5 x 8 x 4.5
Mano Fragment	C	N975/W973	5	Austin	Quartzite	4 x 4.5 x 2.5
Grinding Slab Fragment	C	N975/W973	5	Austin	Sandstone	13 x 12 x 4.5
Grinding Slab Fragment		BHT 4A		Unknown	Sandstone	21 x 12 x 4
Grinding Slab Fragment		Surface		Unknown	Quartzite	8.5 x 7.5 x 2.2

Table 14.6-2 (continued)

ARTIFACT TYPE	AREA	UNIT	LEVEL	CULTURE/TIME Stratigraphic Unit	RAW MATERIAL	DIMENSIONS (cm)
			SITE 41WM267			
Grinding Slab	A	N1000/W990 Feature 5		Clear Fork	Flint	32 x 24 x 6.5
Grinding Slab	B	N1017/W985	10	San Marcos	Quartzite	15 x 26 x 3.5
Grinding Slab	B	N1018/W986	14	Clear Fork	Sandstone	15 x 12 x 2.5
Manuport	B	N1017/W987	26	San Geronimo	Quartzite	7.5 x 6 x 4.5
Manuport	D	N1057/W989.5	71/72	San Geronimo	Quartzite	10 x 6.5 x 5.5
Mano	D	BHT		Unknown	Quartzite	10.5 x 8 x 4.5
Grinding Slab		BHT 3A		Unknown	Quartz	35 x 27.5 x 6
			SITE 41WM368			
Mano Fragment		Surface		Unknown	Quartz	7 x 6.5 x 3

TABLE 14.6-3. Frequency of Ground Stone Artifacts and Manuports by Site by Culture/Time Stratigraphic Unit

Site	Artifact	San Geronimo N	San Geronimo %	Clear Fork N	Clear Fork %	Round Rock N	Round Rock %	RR/SM N	RR/SM %	San Marcos N	San Marcos %	Twin Sisters N	Twin Sisters %	Austin/Toyah N	Austin/Toyah %	Unknown N	Unknown %
41WM53 N = 1	Mano Fragment															1	100
Hawes Site (41WM56) N = 26	Mano, complete			1	33											2	67
	Mano, fragment	2	29	1	14	1	14					1	14			2	29
	Mano/Hammerstone					1	25									3	75
	Mano/Anvil			2	67											1	33
	Grinding Slab			1	100												
	Grinding Slab, fragment			1	20			3	60							1	20
	Abrading Stone															1	100
	Manuport											1	50			1	50
41WM57 N = 6	Mano, complete															1	100
	Mano, fragment							1	33							2	67
	Mano/Anvil							1	100								
	Grinding Slab															1	100
41WM73 N = 12	Mano, complete					1	100										
	Mano, fragment			1	20	4	80										
	Anvil					1	100										
	Grinding Slab					1	100										
	Manuport			1	25	2	50									1	25
41WM304 N = 2	Mortar			1	100												
	Manuport			1	100												
41WM328 N = 4	Mano, complete															1	100
	Mano, fragment											1	100				
	Mano/Anvil											1	100				
	Anvil											1	100				
41WM404	Anvil													2	100		
	Grinding Slab, fragment				(Archaic)	1	100										

TABLE 14.6-4 . Frequency of Ground Stone Artifacts and Manuports by Site by Culture/Time Stratigraphic Unit

Site	Artifact	Culture/Time Stratigraphic Unit															
		San Geronimo		Clear Fork		Round Rock		RR/SM		San Marcos		Twin Sisters		Austin/Toyah		Unknown	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Bryan-Fox Site (41WM124) N = 1	Grinding Slab, fragment											2	100				
41WM126 N = 3	Mano, fragment											1	100				
	Mano/Hammerstone											1	100				
	Grinding Slab, fragment											1	100				
41WM163 N = 2	Mano/Hammerstone																
	Manuport															1	100
Bigon-Kubala Site (41WM258) N = 5	Mano, complete													1	100		
	Mano, fragment													1	100		
	Grinding Slab, fragment													1*	100		
														1*	33	2	67
Cervenka Site (41WM267) N = 5	Mano																
	Grinding Slab			2	50											1	100
	Manuport	2	100							1	25					1	25

* Austin Phase Only

the only sample of Early Archaic assemblages within the Granger Lake Reservoir is from a single site. The Cervenka site (41WM267) may have been essential to the occupation of the site. Other unexamined Early Archaic assemblages within the reservoir may contain larger quantities of ground stone tools.

A greater variety of pecked and ground stone artifacts was recovered from the North Fork assemblages than from the Granger Lake assemblages. Mano/anvils, anvils, mortars, and abrading stones are represented within the North Fork assemblages; however, none were recovered from the Granger Lake reservoir. The low numbers of these artifacts recovered from the North Fork assemblages (Table14.6-1) indicate that this difference may be due to sampling error rather than the functional needs of the site occupants. The significantly smaller volumes of site matrix removed from most of the Granger Lake reservoir sites may not have been sufficient for the recovery of such relatively rare occurrences.

The pecked and ground stone component of these assemblages appears to have been relatively constant through time. No significant stylistic/funtional variability is evident from the material recovered from the eighteen investigated sites at the two reservoirs. Although the possibility of sampling error hinders any definite judgement concerning inter-reservoir comparisons, the higher density of pecked and ground stone tools removed from the North Fork assemblages indicates that such tools were a more important segment of the subsistence system within Edwards Plateau region. Perhaps, ground stone tools were not as necessary for exploiting the resources of the prairie environment surrounding the San Gabriel River valley in the Granger Lake area.

The most interesting attribute of the pecked and ground stone tool assemblage is the raw material type. As noted above, all but nine of these tools are fabricated from raw materials which are not common to the San Gabriel River drainage. These non-local raw materials consist of quartzite, vein quartz, sandstone, and granite. Utilization of these raw materials is quite constant from both a diachronic and synchronic perspective. The significance of the raw material types is derived from the direction and distance to source areas rather than from changing percentages of raw material types.

Two possible source areas exist for quartzite and vein quartz. One is the Llano Uplift region to the west of the San Gabriel River drainage (Sellards, Adkins, and Plummer 1958:32-36). The other possible source area is the Uvalde Gravel deposits which appear on the high divides between streams in Central Texas (Byrd 1971: 10,17). In fact, several areas of Uvalde Gravel rest unconformably upon the Taylor Marl to within the north San Gabriel drainage, east of Pflugerville, and between Manor and Austin, Travis County. These deposits consist largely of quartz, quartzite, chert, limestone, and silicified wood (Byrd 1971:17-18). Individual pebbles and cobbles range from one inch to six inches in diameter.

If the Uvalde Gravel deposits were the source area for the raw materials of the San Gabriel assemblages, quartz and quartzite could hardly be designated as non-local in origin. However, two factors render the Uvalde Gravel deposits an unlikely candidate for the source area. Firstly, accessibility of these gravels in the prehistoric period was likely very poor. Uvalde gravels typically occur in a soil matrix that mantles stream divides. Within the lower San Gabriel River drainage, these divides would have been covered with prairie vegetation during the prehistoric period. Most of the exposure of these gravels today is through cultivation, road cuts, quarrying activities, old channel cuts, and erosion. Old channel cuts would have provided the only readily accessible source of these gravels during the prehistoric period. Secondly, even if these materials had been available, the size of the majority of the cobbles is well below that of the ground stone artifacts of the San Gabriel assemblages. Although six inches (15.3 cm.) is stated as the upper size range for these gravels, most cobbles are significantly smaller (Byrd 1971). Therefore, it is highly unlikely that the Uvalde Gravel deposits served as a primary source area for quartz and quartzite; rather, these materials were likely procured from the Llano Uplift region to the west of the San Gabriel River drainage.

The specific source area for the sandstone utilized by the occupants of the San Gabriel drainage is not so easily traced. Within the North Fork and South Fork drainages of the San Gabriel River, the Lower series of the Cretaceous system does contain sandstone deposits. However, no outcroppings of sandstone are present within the North Fork drainage, (Sellards, Adkins, and Plummer 1958:300-330). Perhaps in the broader expanses of these formations, both to the northwest and to the south, such outcroppings are more common. A more likely source area is the Llano Uplift region. There one can find massive sandstone deposits in the Upper Cambrian system (Sellards, Adkins, Plummer 1958:55-60). Another likely source area is the Wilcox formation of the Tertiary system which outcrops to the east of Cameron and in the Rockdale vicinity. Since the San Gabriel River drainage system flows through this area, it would have been an accessible source area for the inhabitants of the upper San Gabriel drainage.

Deciding which of these three areas was the primary source area for sandstone is quite difficult. Petrographic analysis of the artifacts and the raw material from each source area would be essential to such a determination. Nevertheless, the character and exposure of the sandstones to the east lower its probability of being the primary source area. Most good exposures occur along the banks of the larger streams and in road cuts. Since road cuts were not available prehistorically, the number of outcrops of actual sandstone are limited. Most of the sand within the Wilcox formation is also quite soft and unconsolidated (Sellards, Adkins, and Plummer 1958:571-600). Therefore, it is unlikely that such material, if accessible, would have been regarded as suitable material for ground stone artifacts. The relatively low percentage of sandstone artifacts from the Granger Lake Reservoir sites (14.3%) supports this conclusion. The North Fork Reservoir sites which are closer to the better sources of sandstone yielded a higher percentage of sandstone artifacts (28.6%).

Interestingly, the only source of granite for the North Fork Reservoir assemblages is also the Llano Uplift region to the west (Sellards, Adkins, and Plummer (1958:30-47). The accessibility of all the suitable raw materials--quartzite, vein quartz, sandstone, and granite--from this one region makes it the most likely candidate for the primary source area of blanks for pecked and ground stone within the San Gabriel River assemblages. Whether the bands which occupied the San Gabriel River valley also frequented the Colorado River valley during their subsistence cycle or merely acquired these raw materials through a social-trade network is largely conjectural given our present data base. However, the latter hypothesis is more likely given our knowledge of modern hunter-gatherers. Settlement-subsistence territories of closely related bands usually follow a drainage system rather than cross-cutting several drainages. Whatever the network of procurement of the raw materials, it is apparent that social interaction between the uplands of the Edwards Plateau region and the blackland prairie region was active throughout the prehistoric sequence within the San Gabriel River drainage. However, the level of intensity of this interaction cannot be judged from the ground stone assemblage alone. Synthesis of this data with the other components of the San Gabriel assemblages may allow some insight concerning the intensity of interaction.

Hammerstones

Hammerstones are not very numerous in the San Gabriel project area. Most of these artifacts were collected from the North Fork Reservoir, mainly from site 41WM56 (Table 14.6-5).

All the information about the hammerstones from the major sites is summarized in two tables, one for each reservoir. They mention exact proveniences, i.e. unit and level, a cultural component when known, and measurements. All measurements are expressed in millimeters. Furthermore, there are remarks pertaining to the raw material and the state of the artifact. Most artifacts are complete, but a few are fragmentary or burned. Nearly all the hammerstones are made on flint artifacts, but a few on quartzite pebbles (Tables 14.6-6). Measurement for specimens from site 41WM133 and 41WM230 are not available.

Nine hammerstones were collected from site 41WM56, mostly from a mixed or unknown context. There was only one artifact both at site 41WM57 and site 41WM304, both also from an undated context. One of the hammerstones at site 41WM73 was found in a feature, but is not burned. With four artifacts, site 41WM328 is considered relatively rich. Most of the North Fork Reservoir hammerstones are made on exhausted flint cores. These are usually amourphous multiple platform cores, but there are a few single platform, double platform cores and discoidal cores. Even fewer were made on flint modules or quartzite pebbles. The size of these artifacts is remarkably uniform. Most of the complete artifacts are oval in outline, and both extremities are hammered. Faces were never hammered, but in a few cases, the long edges were used. The larger artifacts are modules or pebbles, the smaller one is only a fragment.

Even fewer hammerstones were collected in the Granger Reservoir. Most come from site 41WM230, 3 from site 41WM267, 2 from site 41WM124 and 1 each from sites 41WM133 and 41WM258. One artifact from site 41WM230 was burned. This site is also the only one where regular tools were re-used as hammerstones. In most cases, they were battered only casually. Most hammerstones were also made on exhausted flint cores, only one on a nodule. This latter tool was the largest artifact. The variation in size is greater here than in the North Fork Reservoir, and the artifacts are a little larger. They are used in much the same way as the North Fork Reservoir hammerstones.

Only one hammerstone was recovered during the survey, i.e. on the surface of site 41WM134. Once again, this tool was made on an exhausted flint core, and is one of the smallest hammerstones recovered during the project (measurements are: l. 60, w. 50, t. 30 mm.).

Table 14.6-5. Hammerstones, North Fork Reservoir

Site	Area	Unit	Level	Cultural Component	Remarks	Measurements in mm. L.	W.	T.
41WM56	B	N1042/W1166	2	mixed	on flint core, burned	62	55	34
	C	N1061/W1097	2	mixed	on flint core	71	61	38
		N1062/W1100	4	mixed	on flint core	75	69	44
		N1063/W1097	4	mixed	flake from core, used as hammerstone	38	33	15
		N1063/W1100	5	Round Rock	on flint core	62	62	39
	D	N1050/W1111	2	mixed	on flint core	71	59	36
		N1049/W1112	5	Round Rock/ San Marcos trans.	on (coarse) flint core. intens.	73	68	45
	E	N1046/W1093	3	*no diagnostics*	*on (coarse) flint nodule*	92	74	36
	F	feature 7	2+3	Twin Sisters	on flint core	72	58	35
41WM57	B	N1037/W1011	1	mixed	on flint core	68	66	29
41WM73		Surface		unknown	on flint core	78	68	44
	A	Feature 1	7	Round Rock	on flint core	69	57	39
41WM304		profile trench 2	99.48m	unknown	on quartzite pebble	80	55	45
41WM328	A	N1000/W1018	4	Twin Sisters	on large, heavy Sb flake	63	90	37
	B	N982/W1001	15	Twin Sisters	on flint core fragments	84	52	38
	B	N982/W1002	16	Twin Sisters	on flint core fragment, burned	46	54	36
		BHT #4-B		unknown	on flint core	47	46	33

Table 14.6-6. Hammerstones, Granger Reservoir

Site	Area	Unit	Level	Cultural Component	Remarks	Measurements in mm. L.	W.	T.
41WM124	A	N801/W803	24	San Marcos	on flint core	66	57	44
	A	N801/W804	27	San Marcos	on flint core	78	52	37
41WM133		general profile	#8	Circleville	on flint core			
41WM230	XU-3	N1022/W996	8	Twin Sisters	on flint core or preform			
	XU-3	N1022/W1000	10	Twin Sisters	on flint biface, burned			
	XU-3	N1026/W996	11	Twin Sisters	on flint pebble			
	XU-3	N1016/W1000	12	Twin Sisters	on scraper			
		Backhoe ramp feature	99	unknown	on flint core			
41WM258		Surface		unknown	on quartzite nodule/pebble	110	55	39
41WM267	A	N1001/W990	6	San Marcos	on coarse flint core	92	75	39
	B	N1018/W986	9	San Marcos	on flint core	97	67	45
	D	N1057/W9885	11	San Geronimo	on flint core	77	67	59

Cores

Introduction

A total of 357 cores were found during excavation in both reservoirs. The majority of these came from the Granger Reservoir (220 or 62%), the remainder came from the North Fork Reservoir (137 or 38%).

A simple core typology was used; the cores were classified according to their platforms:

--Single platform cores: cores with only one platform. This core type was not further subdivided.

--Double platform cores: cores with two platforms. This core type was further divided into:
- -90° cores: the platforms are at a 90° angle to one another.
- -diagonal cores: the platforms are at an oblique angle to one another.
- -opposed cores: the platforms are at opposed ends of the core.

A further distinguishing factor was made between double cores with their platforms on the same or on different faces.

--Multiple platform cores: cores with three or more platforms.

--Wedge cores: as originally defined by Marks (1968, p. 396) but for flakes.

--Subdiscoidal cores: cores flaked around all edges. Some of these may possibly be confused with "preforms."

All the cores were made on flint. No chalcedony cores were found although there are a few tools in this material. There were also no obsidian cores, but a few such flakes were found.

North Fork Reservoir

Site 41WM53

Few cores were recovered at the site; all were from Area A (Table 14.6-7). Two were single platform cores, one small one of medium size. Both retained a small amount of cortex. The third core was a small multiple platform core (3 exhausted platforms), without any cortex. All platforms for all three cores were single facetted prepared platforms. All cores were

flake cores exclusively.

Table (14.6-7) 41WM53 Cores.

CORE TYPES	Austin	Aust./Twin Sist. Trans	Twin Sisters.	TOTAL
Single Platform	1	1		2
Multiple Platform			1	1
Total	1	1	1	3

Site 41WM56

A total of 91 cores were recovered from site 41WM56, 44 (or 58.35%) of which were found in datable context (Table 14.6-8). Most were recovered from the mixed upper levels of Area C and in plowzones.

A. Single platform cores

Twenty-nine cores are single platform cores (11 or 37.93%), all exclusively flake cores. Most cores have a single facetted platform preparation, 10 (or 34.48%) a multifacetted platform preparation. Five cores (or 17.24%) have unprepared cortex platform, two (or 6.90%) mixed cortex and unifacetted platforms. Only one core (or 3.45%) has a crushed platform. The majority of cores have moderate to large amounts of cortex.

Cortex:	51-95%	14	48.28%
	10-50%	8	27.59%
	1- 9%	4	13.79%
	0%	3	10.34%

B. Wedge cores

Three cores were wedge cores, also all exclusively flake cores with 15-20% of their surface covered by cortex.

C. Double platform cores (Fig. 14.6-1)

There were also twenty-nine double platform cores, all six subtypes of which were present at the site. Most cores are exclusively flake cores, but two are blade cores. Of the latter two, one was found in Round Rock context and one in Clear Fork context. The amount of cortex remaining on the cores was noticeably less than on the single platform cores; no core had more than 50% cortex.

Cortex:	51-95%	0	0%
	10-50%	16	55.17%
	1- 9%	5	17.24%
	0%	8	27.59%

Table 14.6-8. 41WM56 Cores.

CORE TYPE	SUBTYPE	Plowzone	Mixed Upper Levels	Twin Sisters	San Marcos/Round Rock Transition	Round Rock	Clear Fork	San Geronimo	Unknown	Subtotal	TOTAL	%
Single Platform		5	8	2	2	3	4	4	1	29	29	31.86
Wedge Cores			1		1			1		3	3	3.30
Double Platform	90^{o} same face		1			1	2	1		5		
	90^{o} same face	2	5				2			9		
	Diagonal, different face	1	1			2				4		
	Diagonal, different face		3	1		1				5		
	Opposed, same face	1	2	1			1			5		
	Opposed, different face						1			1	29	31.87
Multiple Platform		8	7	3	6	1	2	1		28	28	30.77
Subdiscoidal			1			1				2	2	2.20
TOTAL		17	29	7	9	9	12	7	1	91	91	100.00
%		18.68	31.87	7.69	9.89	9.89	13.19	7.89	1.10	100.00		

The majority of the platforms were unifacially prepared (65%); 26% are cortex platforms and only 9% are multifacetted platforms.

D. Multiple platform cores

Most cores are triple platform cores (18 or 66.67%); there are six (or 22.22%) quadruple cores and three (or 11.11%) quintuple cores. All except one were flake cores. One core has one blade negative, but all other removals were flakes. Most cores had a relatively large amount of cortex.

Cortex:	51-95%	2	7.41%
	10-50%	13	48.15%
	1- 9%	6	22.22%
	0%	6	22.22%

Most platforms have a unifacial preparation (55%); 16% have multifacetted platforms, 27% have a cortex or older patinated platform, while 2% have crushed platforms.

E. Subdiscoidal cores.

Two cores are subdiscoidal/suboval, one of which was burned. Both are flake cores with little or no cortex left.

Site 41WM57

A total of 17 cores was recovered from the undisturbed parts of site 41WM57 (Table 14.6-9). The majority were recovered in a San Marcos/Round Rock transition context (16 or 94.12%), only one in the Clear Fork component. Multiple cores form the largest category with 9 cores. Most of these have at least one unifacially prepared platform, mixed with multiple facetted or cortex platforms. Four single platforms all have a single facetted platform.

The one subdiscoidal core has two blade negatives. Three cores were wedge cores. Double platform cores were absent in this sample. Most cores had between 10-30% cortex left, only three had no cortex at all.

Table 14.6-9. 41WM57 Cores.

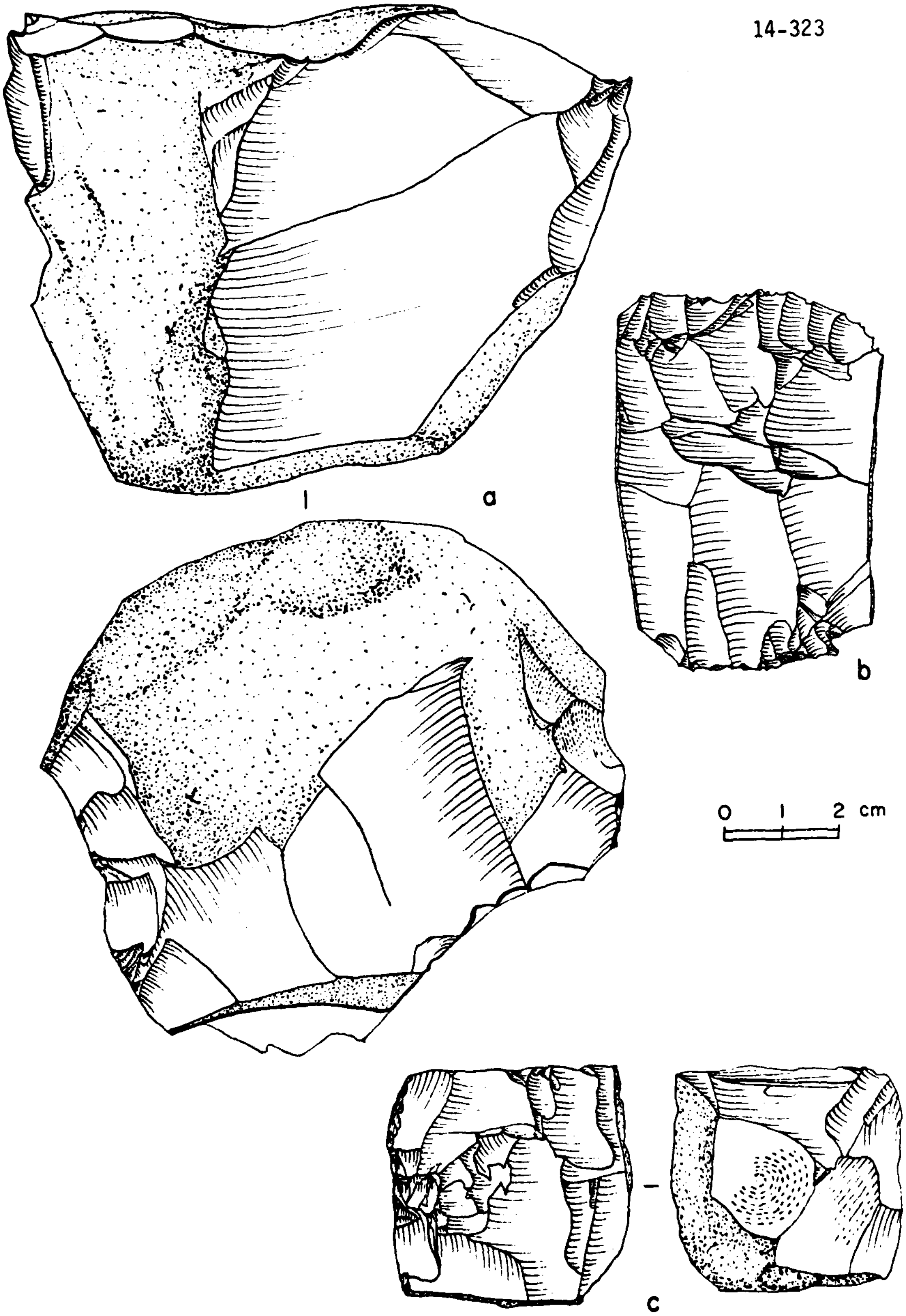
CORE TYPE	San Marcos/Round Rock Transition	Clear Fork	TOTAL	%
Single platform	4		4	23.53
Wedge	3		3	17.65
Multiple platform	8	1	9	52.94
Subdiscoidal	1		1	5.88
TOTAL	16	1	17	
%	94.12	5.88	100.00	100.00

FIGURE 14.6- 3

DEBITAGE ELEMENTS: CORES.

	Site	Type
a	41WM267	single platform core, two views.
b	41WM163	double platform core, opposed platforms, on the same face.
c	41WM56	double platform core, crossed (or 90^{o}) platforms, same face; two views.

14-323



Site 41WM73

Six cores were collected at site 41WM73, all during excavation of Area B only (Table 14.6-10). Two cores are irregular subdiscoidal cores, two are single platform cores, one with a cortex platform and the other with a single facetted platform. One wedge core and one double core, the platforms opposed on the same face, are also present. All but one of the single platform cores had little (5-10%) cortex left; the one exception was more than half covered by cortex.

Table 14.6-10. 41WM73 Cores.

CORE TYPE	Round Rock	Round Rock/Clear Fork Transition	Mixed	TOTAL
Single platform	2			2
Wedge core	1			1
Double platform	1			1
Subdiscoidal		1	1	2
TOTAL	4	1	1	6

Site 41WM304

A total of 11 cores was excavated at site 41WM304 (Table 14.6-11). Most of them are single platform cores. There are three double platform cores, one with opposed platforms on the same face, one diagonal core on different faces, and one 90° core, also on different faces. There are also three multiple platform cores and one discoidal core.

Single platform cores have a unifacetted platform preparation or no preparation (cortex platform); all other cores also have unifacetted and cortex platforms in about equal proportions; the remaining cores have mixed platform preparations.

All cores show flake removal exclusively. Two of the single platform cores had 40%, and 60% of cortex left, but all other cores have between 5% and 15% of cortex left only.

Table 14.6-11. 41WM304 Cores.

CORE TYPE	SUBTYPES	Round Rock	Clear Fork	San Geronimo	SUB TOTAL	TOTAL	%
Single Platform			3	1	4	4	36.36
Double platform	opposed same face		1		1		
	90° different face		1		1		

	diagonal different face		1		1	3	27.27
Multiple platform		1	2		3	3	27.27
Subdiscoidal				1	1	1	9.09
TOTAL		1	8	2	11	11	
%		9.09	72.73	18.18	100.00		99.99

Site 41WM328

A total of nine cores was collected at site 41WM328, the majority (7 or 78%) from the Twin Sisters component of the site (Table 14.6-12).

Most are multiple platform cores; there are also three single platform cores and one subdiscoidal core, the latter from the Austin component of the site.

Table 14.6-12. 41WM328 Cores.

CORE TYPES	Austin	Twin Sisters	Unknown	TOTAL	%
Single platform		2	1	3	33.33
Multiple platform		5		5	55.56
Subdiscoidal	1			1	11.11
TOTAL	1	7	1	9	100.00
%	11.11	77.78	11.11	100.00	

Granger Reservoir

Site 41WM124

A total of 18 whole cores was recovered from the site (Table 14.6-13). Most of them are multiple platform cores, four triple and three quadruple cores; one core had an undetermined number of platforms. Only one core has no cortex, the others all had 10-35% cortex.

Single and double cores occur in equal amounts, i.e. 5. All these cores retain cortex, the single platform cortex usually less than 40%, the double cores between 30 and 80%. All cores have manily unifacial platform preparations (56%); 25% have unprepared cortex platforms, 11% multifacetted and 8% are crushed. The majority of the cores recovered from Area A (14 or 78%), the others in Areas B and C (2 from each area).

Site 41WM133

A total of six cores was collected during this site's excavati ., one

Table 14.6-13. 41WM124 Cores.

CORE TYPE	SUBTYPE	Austin	Sisters	Marcos	Fork	Mixed	Subtotal	TOTAL	%
Single platform		1	2	2			5	5	27.78
Double platform	90^{o}, same face		1				1		
	90^{o}, different face				1			1	
	diagonal, different face				1			1	
	opposed, different face	1		1			2	5	27.78
Multiple platform		2	3		2	1	8	8	44.44
TOTAL		4	6	5	2	1	18	18	100.00
%		22.22	33.33	27.78	11.11	5.56	100.00		

Table 41WM230 Cores.

CORE TYPE	SUBTYPE	Neo American	Toyah	Austin	Twin Sisters	San Marcos	Round Rock	Un-Known	Sub-Total	TOTAL	%
Single platform		1		5	20	5	2		33	33	44.59
Double platform	90^{o}, same face				2		1		3		
	90^{o}, different face	1			6				7		
	diagonal, same face	1			1				2		
	diagonal, different face							1	1		
	opposed, same face				1				1		
	opposed, different face				1				1		
	other				2	1	1		4		25.68
Multiple platform		2	1	2	13	2	2		22	22	29.73
TOTAL		5	1	7	46	8	6	1	74	74	
%		6.76	1.85	9.46	62.16	10.81	8.11	1.35	100.00		100.00

from excavation unit 6, the other five from excavation unit 5.

Four are single platform cores, two small, two large. Two have unifacetted platforms, the other two multifacetted, although one of the latter in combination with cortex.

The other two are double platform cores, both 90^{o} cores. Both have one unifacetted platform, the other platform either cortex or multifacetted and both are rather small.

Cortex is present on all cores, but more exact amounts were not recorded. All cores were for flakes only.

Site 41WM163

A relatively large number of cores (23) was found at site 41WM163, although mostly from undatable backhoe trench context (Table 14.6-14). Eight cores are single platform cores, eight are double platform cores. There was little patterning in platform preparation. The distribution is more or less equal between cortex and unifacial platforms, often mixed in double and multiple cores, and multifacetted cores are present but not abundantly. Two cores are partially blade cores, two others may have some bladenegatifs.

Table 14.6-14. 41WM163 Cores.

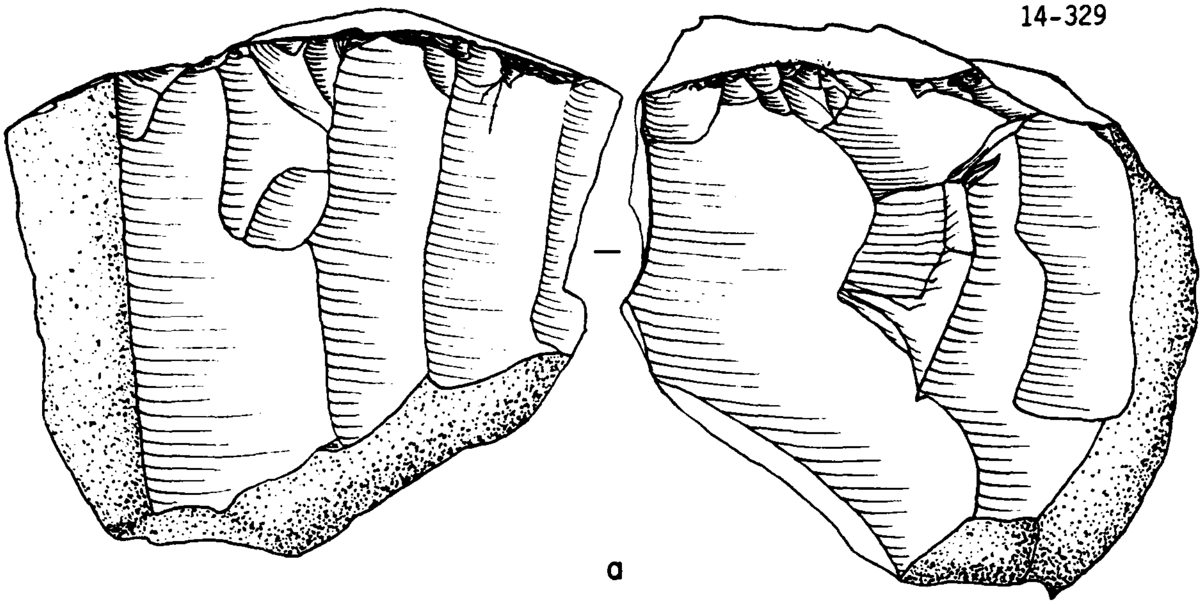
CORE TYPE	SUBTYPE	Twin Sisters	San Marcos	Round Rock	Surface & BHT	Sub Total	TOTAL	%
Single platform				1	7	8	8	34.78
Dougle platform	90^{o} different face			1		1		
	diagonal, same face				1	1		
	diagonal, different face				1	1		
	opposed, same face	1	1		1	3		
	opposed, different face				1	1		
	amorphous				1	1	8	34.78
Multiple platform				1	6	7	7	30.44
TOTAL		1	1	3	18	23	23	100.00
%		4.35	4.35	13.04	78.26	100.00		

FIGURE 14.6-4

DEBITAGE ELEMENTS: CORES.

	Site	Type
a	41WM267	single platform bladecore, two views.
b	41WM328	subdiscoidal core, two views.

14-329



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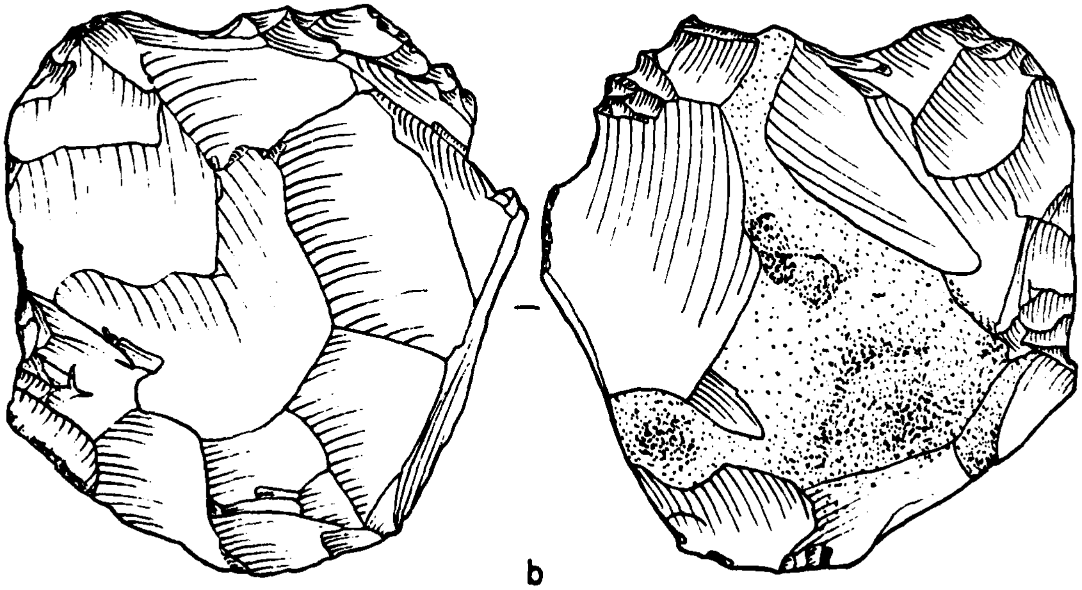


b

Site 41WM230

A total of 74 cores was recovered from site 41WM230 (Table 14.6-15). All except one were found in a datable context.

A. Single platform cores.

There were 33 single platform cores (44.59%). Most cores had a unifacetted platform preparation (15 or 45.45%). Eight cores have no preparation, i.e. have cortex platforms (24.24%), seven (21.21%) have multifacetted platforms. Three cores have unidentifiable crushed platforms (9.09%).

All but one core preserved some cortex. Quantitative data on the approximate amount of cortex present on the cores was not recorded for this site.

B. Double platform cores.

There were 19 (25.68%) double platform cores, divided into several subtypes (Table 14.6-15). Six cores have unprepared platforms only (31.58%), four unifacetted platforms only (21.05%). All the other cores have two differently prepared platforms, mostly with at least one unifacetted one. There are only two cores where a multifacetted prepared platform occurred. All the double platform cores retain some amount of cortex.

C. Multiple platform cores.

There were 22 multiple platform cores (29.73%). All cores but six have at least two different types of platform preparations. In most cases, at least one of the platforms is unifacetted. Five cores have only single facetted platforms, one core has only cortex platforms.

There are mostly triple platform cores, few quadruple cores. Only one core has five platforms. One core only has no cortex.

Site 41WM258

A total of seven cores was collected from site 41WM258, only from unknown or from the Neo-American component of the site (Table 14.6-16). The Archaic levels did not produce any cores.

All cores are flake cores only, and all core platforms were unifacially prepared, except one platform on a double platform core, which is on unprepared cortex platform.

Table 14.6-16. 41WM258 Cores.

CORE TYPE	SUBTYPE	Toyah	Austin	Neo-American	Unknown	Sub-Total	TOTAL
Single platform			1		2	3	3
Double platform	90^o, same face	1		1		2	

TABLE 14.6-15. 41WM230 Cores.

CORETYPE	SUBTYPE	Neo American	Toyah	Austin	Twin Sister	San Marcos	Round Rock	Un-Known	Sub Total	Total	%
Single platform		1		5	20	5	2		33	33	44.59
Double platform	90^o, same face				2		1		3		
	90^o, different face	1			6				7		
	diagonal, same face	1			1				2		
	diagonal, different face							1	1		
	opposed, same face				1				1		
	opposed, different face				1				1		
	other				2	1	1		4	19	25.68
Multiple platform		2	1	2	13	2	2		22	22	29.73
TOTAL		5	1	7	46	8	6	1	74	74	
%		6.76	1.85	9.46	62.16	10.81	8.11	1.35	100.00		100.00

	diagonal, same face				1	1	3
Multiple platform		1				1	1
TOTAL		2	1	1	3	7	7

Site 41WM267

There were in total 92 cores from site 41WM267, nearly all of which were found in a datable context (Table 14.6-17). The majority of cores was from the Clear Fork period.

A. Single platform cores.

There are 27 (or 29.35%) single platform cores. All except one are flake cores; the one exception is a mixed flake and blade core. Most cores have no platform preparation at all, and are covered with cortex (15 cores, 55.56%). Other cores have prepared platforms, both single facetted and multiple facetted, in equal numbers (5 each, 18.52%). Two cores had mixed prepared/unprepared platforms. All cores retain some cortex:

Cortex:	51-95%	11	40.74%
	10-50%	15	55.56%
	1- 9%	1	3.70%
	0%	0	

B. Wedge cores.

Two cores are wedge cores, both flake cores, with about 30% of their surfaces still covered with cortex.

C. Double platform cores.

There are 27 double platform cores. For a subdivision into more distinct types, (Table 14.6-17). Note that there are no 90^{o} double platform cores on the same side, at this site. Nearly all the double platform cores are flake cores also; one core has blade as well as flake scars, and another core is possibly a blade core also (but these scars were obliterated partially by flake scars). Most cores have at least one unifacetted. Three cores (11.11%) have both platforms unprepared (cortex), and one core has one cortex and one crushed platform.

The cortex distribution on the cores was as follows:

51-95%	6	22.22%
10-50%	15	55.56%
1- 9%	4	14.81%
0%	2	7.41%

TABLE 14.6-17. 41WM267 Cores

CORE TYPE	Subtype	Twin Sisters	San Marcos	Clear Fork	San Geronimo	Unknown	Subtotal	TOTAL	%
Single platform		2	6	13	6		27	27	29.35
Wedge core		1			1		2	2	2.17
Double platform	90^o same face								
	90^o different face	1	1	4	2		8		
	diagonal, same face		1	2			3		
	diagonal, different face		2			1	3		
	opposed, same face		1	1	1		3		
	opposed, different face		2	2	3		7		
	other			2	1		3	27	29.35
Multiple platform		1	8	10	10		29	29	31.52
Subdiscoidal			1	2	4		7	7	7.61
TOTAL		5	22	36	28	1	92	92	
%		5.43	23.91	39.14	30.43	1.09	100.00		100.00

D. Multiple platform cores

The majority of the cores at this site are multiple platform cores, mostly with three distinct platforms. All except one are flake cores; the one exception has flake as well as blade scars. Most cores show a combination of unifacetted prepared and unprepared cortex platforms (15 or 51.72%) or unifacetted prepared platforms only (7 or 24.14%). Most others are combinations with unifacetted platforms, and one core with multifacetted preparation and cortex platforms.

The cortex distribution on the cores was as follows:

51-95%	7	24.14%
10-50%	18	62.07%
1- 9%	3	10.34%
0%	1	3.45%

E. Subdiscoidal cores.

There are seven discoidal or suboval cores, all flake cores, with little cortex remaining, i.e. between 10 and 30%.

14.7 Bone Artifacts

by

Bonnie C. Yates

A total of 188 pieces of modified bone was recovered from four sites in the North Fork reservoir area (41WM53, 56, 73, 404) and five sites in the Granger reservoir (41WM124, 126, 230, 258, 267). The North Fork sites yielded 64% of the total pieces, and sites at Granger yielded 35%. Very few complete tools were found and only five pieces were recovered from designated features. Most of the altered bones were identified after excavation, during cleaning and sorting procedures.

Recognition of alteration indicators (polish wear and fabrication scars) is hampered by obliteration caused by preservation factors such as soil chemicals, root etchings, animal gnawing and post-recovery cleaning and handling. In these samples, surficial damage is greatest to unburned bones, and most of the burned pieces are very fragmentary. Because of damage and fragmentation, few inferences of use can be made. Therefore, the intention of this study is to provide descriptive documentation of the bone tool remnants from these Central Texas sites.

Methodology

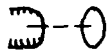
For analysis, the bone artifacts were separated by tip morphology and species/element distinction when possible. A classification scheme similar to Harrell (1980) and Newcomer (1974) has been adapted to describe morphology of these tools (Fig.14.7-1). Two basic tip profiles are found in this assemblage: pointed or blunt. Pointed tips are those that terminate in a point from tapered edges. Blunt tips are obtuse and terminate from parallel edges. Some of the pointed tips taper gradually and in cross section are round; these tip types are termed "conical." Other pointed tips are flattened in cross section and are called "flat." Sometimes a flat shaft of a fragment has been constricted and sharpened into a conical tip. Blunt tips are either round in cross section or flat.

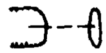
Four other morphological classes are identified in this assemblage: bifurcate, triangulate, flaked, and double pointed (Fig. 14.7-1). The term bifurcate describes flat-sectional, forked tips; triangular describes any spiral-fractured fragment shaped into a working tip or shafts that were incompletely rounded; flaked fragments are those from which flakes have been removed to form working edges; and double-pointed fragments have bipolar pointed tips. Fishhook and decorated fragments are included in a separate class.

All measurements are taken in centimeters of entire specimens except where noted. Measurements of thickness are made at centerpoint of specimen and are expressed in millimeters. State of preservation and degree of polish are admittedly subjective and relative in degree. "Charred" refers to light fire-treating which generally results in brown outer coloring; "burned" refers to intensive heat treatment resulting in black, white, or blue coloration.

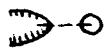
Figure 14.7-1
Classification of Altered Bone

Class I Parallel Sides, Blunt Tip

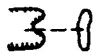
A. Rounded Tip 

B. Flat Tip 

Class II Tapered Sides, Pointed Tip

A. Conical Tip 

B. Flat Tip 

Class III Bifurcate Tip 

Class IV Triangulate Tip 

Class V Ornament

Class VI Flaked Edge

Class VII Other

The following catalog is organized by cultural component and tool class. A brief physical description is include for each. Terms that imply function are generally avoided in this report; instead, terms describing morphology are preferred. For example, a pointed tool can be called an awl, even though its true function is difficult or impossible to ascertain when in a fragmentary or poorly preserved condition. A pointed tip might have been used as a pin, a needle, a bodkin, a hairpin or a drill.

San Geronimo. Twelve bone tools from two sites are recorded from this period: six from Cervenka (41WM267) in the Granger Reservoir and six from the Hawes Site (41WM56) in the North Fork Reservoir.

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks
Base	deer ulna	6	41WM267-D	4.5	unburned; poor condition.
Base	canid ulna	1132	41WM56-C	2.3	burned; proximal end cut obliquely at semi-lunar notch; highly polished.
Base	canid ulna	259	41WM56-B	3.3	burned; highly polished; some longitudinal striations.
IB	artiodactyl ulna	266	41WM56-B	3.5	burned; interosseus notch abraded; fire spalled; tip missing (old break); moderate polish.
IB	fragment	1211	41WM56-C	9.8	unburned; thin, thoroughly ground splinter of long bone.
IIA	artiodactyl metapodial	163	41WM267-D	15.5	unburned; complete, longitudinal striations; highly polished; similar in shape to 1211.
IIB	fragment	155	41WM267-D	2.0	unburned; plane of flattened constricted tip runs perpendicular to flat plane of shaft.
IIB	fragment	332	41WM267-D (E5)	1.7	unburned; tip missing; some polish, although poor condition.
IIB	fragment	8	41WM267-D (E6)	1.3	unburned; well ground: retains traces of spongy tissues on one side; highly polished, tip is constricted, perhaps whittled to resharpen.

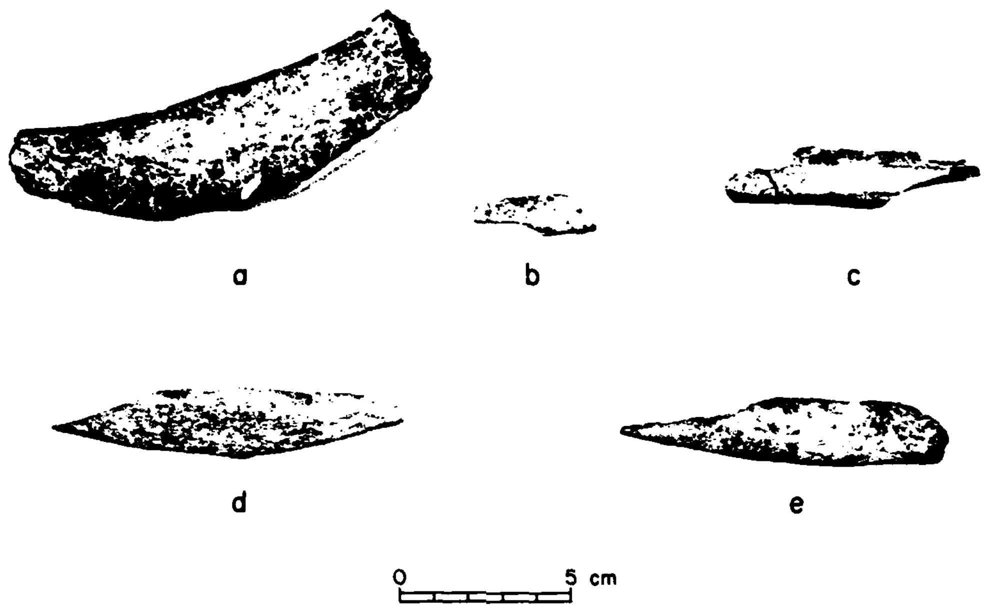


Figure 14.7-2. Assorted bone tools made from large mammal long bone fragments.

a. 41WM267 (#157), bison limb fragment, Class VI, San Geronimo
b. 41WM230 (#52), fragment, Class VII, Twin Sisters
c. 41WM56 (#1729), artiodactyltibia, Class VI, Hawes Mixed Upper Zone
d. 41WM56 (#1715), artiodactyl, Class IIA, Backhoe Trench
e. 41WM56 (#1716), artiodactyl, Class IV, Backhoe Trench

IV fragment 1735 41WM56-D 2.0 burned; lunate with wear and retouch (?) along worked notch.

VI bison limb 157 41WM267-D (D11) 12.6 unburned except where charred along flaked edge; light polish in two areas along longitudinal breakline; slight wear (Fig.14.7-2a).

Clear Fork. Seventeen tools or worked pieces of bone are recorded from Cervenka (41WM267) and Hawes (41WM56), ten from the former and seven from the latter. Deer ulna tools are most common from Cervenka. Three of the four ulnae come from the bone bed (Feature 9) and all are broken and without tips although the remaining shafts indicate a working end that is flat in cross-section with parallel sides terminating in a blunt tip such as those described as ulna flakers (Harrell 1980, Olsen 1979). Deer metapodial tools with thin flat shafts and related fragments characterize the from the Hawes Site.

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks
IB	3 deer ulnae	594 738 739	41WM267-D (Fea. 9)	9.2 8.9 8.9	all 3 unburned; all broken approximately 3.8-4.0 cm below coronoid process; all exhibit some polish and light wear (Fig.14.7-3a).
IB	deer ulna	206	41WM267-B	8.0	unburned except for charred break on working end perhaps in attempt to reshape or harden (Fig.14.7-3b).
IB	fragment	1568	41WM56-E	1.0	unburned tool shaft; thin (1.8 mm) and narrow (5.8 mm); highly polished with longitudinal striations.
IB	fragment	1161	41WM56-C	2.3	unburned tool shaft, thin (2.2 mm) and narrow (9 mm), highly polished.
IIA	canid radius	271	41WM267-D (D11)	2.0	unburned complete tool; proximal radius serves as base; transverse striations occur around constricted tip.
IIA	artiodactyl	165	41WM267-A	8.2	unburned long bone, split longitudinally and shaped to form pointed tool; shaft is triangular in section; tip is highly polished; many fine longitudinal striations cover surface.
IIA	deer antler	351	41WM267-B	8.3	unburned tine; surface covered with nicks; tip is cut at an angle, smoothed, with a high polish along one edge.

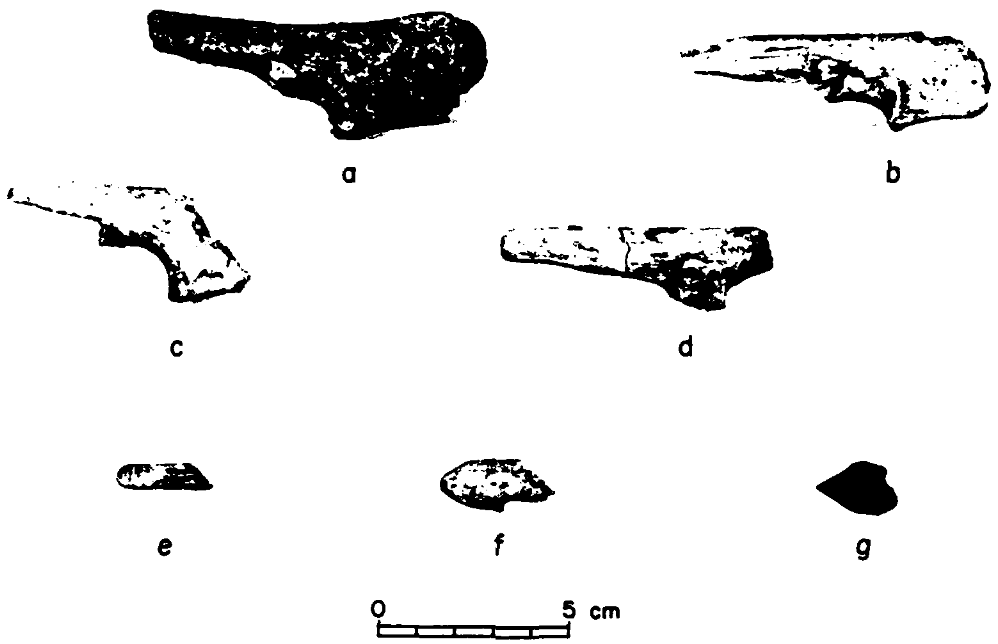


Figure 14.7-3. Ulna tools.

a. 41WM267 (#739), deer ulna, Class IB, Clear Fork.
b. 41WM267 (#206), deer ulna, Class IB, Clear Fork.
c. 41WM56 (#1733), deer ulna, Base, Hawes Mixed Upper Zone
d. 41WM56 (#1036), deer ulna, Class IB, Hawes Mixed Upper Zone
e. 41WM56 (#348), fragment, Class IB, Hawes Mixed Upper Zone
f. 41WM56 (#344), fragment, Class IIB, Hawes Mixed Upper Zone
g. 41WM56 (#1561), fragment, Class IIB, Hawes Mixed Upper Zone

IIA fragment 659 41WM267-D 3.4 unburned tip; light polish, some longitudinal striations.

IIA fragment 1186 41WM56-C 2.9 burned terminal shaft section, highly polished; many heavy longitudinal striations.

IIB deer metapodial 1594 41WM56-E 9.5 unburned complete tool; proximal end serves as base; made from longitudinally split medial or lateral portion of element; poor condition prohibits wear pattern analysis (Fig.14.7-4a).

V deer metapodial 368 41WM267-D (E12) 1.9 unburned; "pendant-" shaped proximal fragment, utilizing natural posterior foramen for hole instead of drilling one.

VII fragment 348 41WM267-D (E11) 1.8 unburned ornament (?) blank; lozenge shape completed at one end; highly polished.

VII fragment 1162 41WM56-C 1.9 unburned; groove and snap marks (Fig.14.7-5a).

Base deer metatarsal 1154 41WM56-C 3.6 unburned proximal portion with foramen; light oblique cuts, deeper transverse cuts, and heavy longitudinal cuts inside anterior grooves such as madein preparation of tool fabrication.

Base deer metapodial 1368 41WM56-D 5.8 unburned proximal portion, tip missing; thin (3.6 mm), narrow (10.7 mm); highly polished with light, longitudinal striations.

Round Rock/Clear Fork. A total mixture of eleven tools and tool fragments are recorded from levels containing lithic artifacts associated with Round Rock and Clear Fork occupations. Nine come from 41WM73 and two come from the Hawes Site (41WM56) where one was recovered from a level with no diagnostic lithics (level 3, Area E). This level was sandwiched between a Clear Fork component and a higher zone that contained a little of everything, but primarily Round Rock artifacts. The other piece from Hawes is broken into two fragments one of which (#1161)was recoveredinlevel 7 and the other (#374) in level 5. This suggests some kind of taphonomic disturbance such as occurs when seasonal drought causes large cracks in the earth allowing artifacts to fall through and become associated with earlier living surfaces. The bone tool assemblage from 41WM73 includes some of the best preserved tools of the San Gabriel collection with thin metapodial tools, ulna tools, and a possible fishhook.

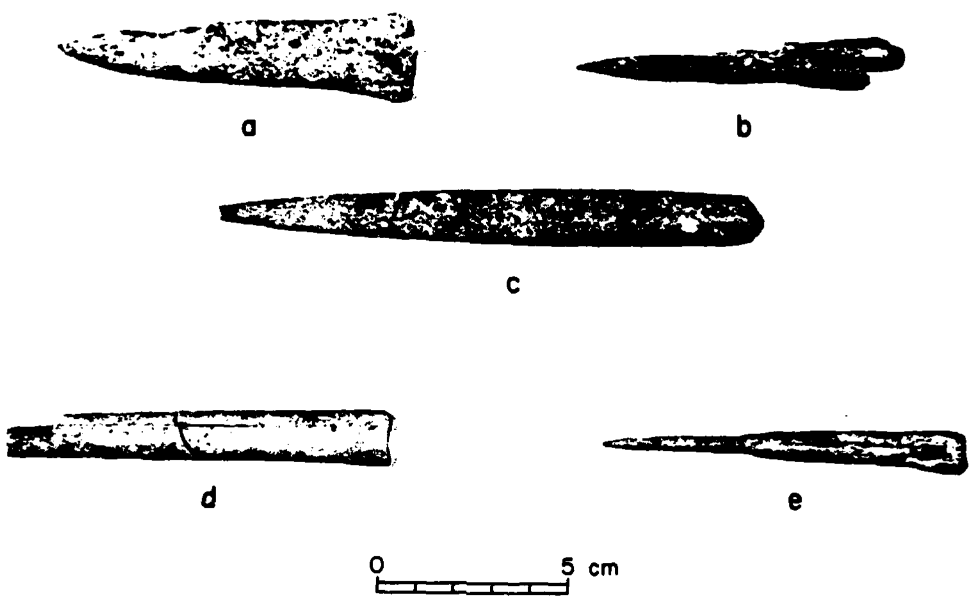


Figure 14.7-4. Metapodial tools.

a. 41WM56 (#1594), deer metapodial, Class IIB, Clear Fork.
b. 41WM73 (#255), deer metatarsal, Class IIA, Round Rock/Clear Fork
c. 41WM73 (#192), deer metapodial, Class IIB, Round Rock/Clear Fork
d. 41WM56 (#258/209), deer metapodial, Class IB, Round Rock
e. 41@M258 (#49), deer metapodial, Class IIA, Twin Sisters

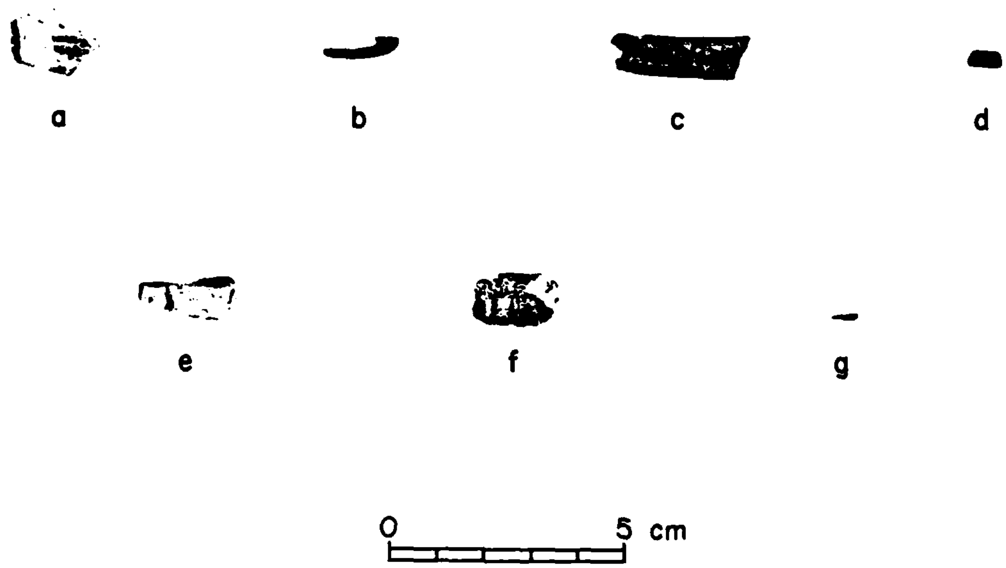


Figure 14.7-5. Worked bone.

a. 41WM56 (#1162), fragment, Class VII, Clear Fork.
b. 41WM73 (#290), fragment, Class VII, Round Rock/Clear Fork.
c. 41WM73 (#310), fragment, Class III, Round Rock.
d. 41WM73 (#288), fragment, Class V, Round Rock.
e. 41WM56 (#752), deer antler, Class VII, San Marcos.
f. 41WM124 (#99), fragment, Class V, Twin Sisters.
g. 41WM230 (#2567), fragment, Class IIA, Neo-American.

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks
IA	fragment	424	41WM73-B	3.0	lightly charred broken tip; highly polished; heavy longitudinal striations.
IIA	deer metatarsal	255	41WM73-B	8.5	unburned; complete tool; shaft split longitudinally, includes anterior groove; highly polished; fine longitudinal striations on tip, deeper fabrication scars near base (Fig. 14.7-4b).
IIB	deer ulna	384	41WM73-B	11.6	unburned except near tip; tip missing; moderately polished shaft; longitudinal striations extend from tip past coronoid process; striations are more prevalent on lateral position; working end is longer and more tapered than other ulna tools.
IIB	deer metapodial	374/ 192	41WM73-C	14.3	unburned; complete except for extreme tip; shaft split longitudinally; lateral or medial section completely smoothed although basal end retains evidence of marrow cavity; thin (3.2 mm), narrow (14 mm); entire surface is polished; fine longitudinal striations extend entire length (Fig. 14.7-4c).
IIB	fragment	315	41WM73-B	1.6	unburned tool shaft; tip broken leaving scar on shaft; edges slightly tapered, may have been portion of tip from ulna or metapodial tool; lightly polished, fine longitudinal striations.
IIB	fragment	1546	41WM56-E	2.9	charred tool tip; thin (1.9 mm), narrow (8.7 mm); faint polish is visible although piece is in very poor condition.
IIB	fragment	317	41WM73-B	2.0	burned tool shaft; tip broken leaving scar on shaft; highly polished; deep longitudinal striations; intensively used before discarded.
IV	fragment	398	41WM73-B	3.3	burned complete double pointed microtool; one tip shows recent break; remaining tip is triangulate with high polish and short striations.
IV	deer metapodial	309	41WM73-B	3.7	charred; split longitudinally; proximal portion serves as base, very poor condition; some polish visible near tip which exhibits old break and is now encrusted with calcium carbonate.
VII	fragment	290	41WM73-B	1.6	charred fishhook(?) fragment (Fig. 14.7-5b).

VII fragment 41WM56-E 5.3 unburned shaft of ulna tool; possibly broken during fabrication, slight discoloration and polish near basal break.

Round Rock. Ten pieces of modified bone are recorded for this component from three sites: a "groove and snap" fragment from Loeve-Fox (41WM203), two tools from the Hawes Site (41WM56) and six tool fragments plus one bone bead from 41WM73.

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks
IB	deer metapodial	209/258	41WM56-B	10.0	unburned; complete except for extreme tip, tool terminates in old break; metapodial was split longitudinally,and lateral or medial portion was ground thin and flat; recovered in two fragments (#209 from level 4 and #258 from level 6); faint polish is visible although surface is badly eroded (Fig. 14.7-4d).
IIA	fragment	62	41WM73-B	0.9	unburned terminal tip; slightly polished; very little wear; probably broken shortly after manufacture.
IIA	fragment	221	41WM73-B	0.8	unburned terminal tip; highly polished; many deep longitudinal striations, two transverse striations at end which has pre-depositional damage; probably broken in use.
IIB	fragment	303	41WM73-B	1.9	charred broken tip; polish visible although poorly preserved; curvature of marrow cavity present.
III	fragment	310	41WM73-B	2.9	unburned tip; thin (2.7 mm), narrow (8.4 mm); polish visible on extreme tip;some longitudinal striations; one prong of bifurcate is charred; both tips are damaged possibly by use (Fig. 14.7 -5c).
IV	fragment	360	41WM73-B	2.5	charred broken tip; shaft portion is completely smoothed; polish visible although poorly preserved; tip probably damaged in use.
IV	deer metatarsal	345	41WM73-B	5.3	burned shaft fragment; abrasion on edges of anterior groove; one deep and three faint, V-shaped, transverse cuts with loss of surface bone midway on shaft; some faint longitudinal striations near break on working end; possibly broken during manufacture.

V	fragment	288	41WM73-B	0.6	burned tubular bead; beveled edges; highly polished (Fig. 14.7-5d).
VII	fragment	1722	41WM56-B	3.1	unburned double-pointed tool made from spirally fractured fragment; one tip unused although lightly polished; worked tip is flaked from one side, lightly polished exhibiting faint transverse striations.
VII	fragment	2512	41WM230-1	2.3	burned white, groove and snap cut, spiral fracture opposite; groove extends only half way through thickness; light oblique cuts transect the groove.

San Marcos/Round Rock. This mixed zone yielded three modified bones, one from Bryan-Fox Site (41WM124) and two from the Hawes Site (41WM56).

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks
Base	deer ulna	40	41WM124	5.2	unburned notch portion; badly damaged; evidence of polish and wear on distal-most end.
IB	fragment	1389	41WM56-D	1.9	burned shaft, thin (2.3 mm) and narrow (6.2 mm); slightly polished, scant longitudinal striations on both sides.
VI	fragment	1736	41WM56-D	2.3	burned tip; lightly polished; faint longitudinal striations on tip.

San Marcos. Five modified bone items are recorded from four sites containing this component. Except for an antler tip, all of these pieces are radically different from tools or modified bones from other components. Metacarpals are more prevalent than metatarsals, and no ulna tools were found.

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks
IA	deer metacarpal	60	41WM267-A	6.2	unburned diaphysis; proximal epiphysis missing or ground off leaving beveled edge with light polish.
IIA	deer antler	122	41WM124-A	2.1	unburned tip; two transverse, V-shaped cuts and several nicks; slightly polished.
IV	deer metacarpal	103	41WM267-A	6.8	unburned complete tool; distal condyles serve as base; anterior wall serves as shaft and base, posterior wall cut and removed; spirally fractured shaft terminates in triangulate point; light polish and smoothed edges suggest minimal use.

V fragment 1058 41WM230-3 0.9 unburned; four deep V-shaped cuts perpendicular to long axis of fragment occur across curved edge; similar to grooved pieces from 41WM124; cuts may be multiple attempts at groove and snap procedure.

VII deer antler 752 41WM56-B 1.9 burned tip; split longitudinally; deep transverse cut as in ring and snap technique (incomplete) (Fig. 14.7-5e).

Twin Sisters. Sixteen pieces of modified bone are recorded from sites containing this component. From North Fork, only 41WM53 and 41WM56 yielded bone artifacts (one from each). At Granger, the test pits at 41WM126 produced seven bone tool fragments; four are recorded from Loeve-Fox (41WM230); two from Bryan Fox (41WM124), one of which is decorated (#99); and one complete tool from Bigon-Kubala (41WM258).

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks
I	4 fragments	27a	41WM126 (T.P. 5)	2.9, 2.0, 1.9, 1.3	all unburned except for end of longest fragment which is charred, all broken longitudinally; all exhibit light polish and faint striations; none of the pieces articulates with any other; very poor condition
IA	fragment	117	41WM53-A	1.2	unburned tip; made from spirally fractured fragment shaped to a blunt tip; large fracture scar near tip; little evidence of wear.
IIA	deer metapodial	49	41WM258-A	9.5	unburned complete tool; made from longitudinally split section with proximal end of element serving as base; shaft is completely abraded; triangular in cross section tapering to a constricted tip (3.6 cm from point) which is conical in section; light polish is visible although surface is badly eroded; some longitudinal striations on tip (Fig. 14.7-4e).
III	fragment	1022	41WM230-3	--	see Prewitt's bone artifact discussion, this volume; specimen #1142.
V	fragment	99	41WM124-B	1.8	unburned decorated fragment; made from deer-size long bone wall; five deep transverse grooves cut into side of fragment; spacing is equidistant. (Fig. 14.7-5f).

VII fragment 52 41WM230-3 3.7 unburned broken tool; made from deer-size long bone wall completely shaped and smoothed; one end and adjoining edge exhibit slight polish and tiny transverse striations; possibly used as a fiber scraper (Fig. 14.7-2b)

VII fragment 1020 41WM230-3 -- see Prewitt's bone artifact discussion, this volume; specimen #1000.

VII fragment 381 41WM230-3 -- unburned double-pointed,spirally fractured fragment, one end possibly used as suggested by slight polish.

VII fragment 12 41WM126-A 1.9 burned; highly polished; evidence of fabrication exists as deep longitudinal cuts along one side, covering two-thirds of the length; the remaining one-third is a small tang, concial in cross-section with transverse cuts near breakline; entire surface covered with light longitudinal striations; too fragmentary to assess function.

VII deer metapodial 35 41WM124-A 3.3 burned proximal fragment with unburned fragment of shaft; evidence of fabrication (deep longitudinal cuts) along length of shaft fragment; damaged by carnivore gnawing.

VII fragment 154 41WM56-A 2.3 unburned groove and snap fragment; rectangular in shape; possibly cut that way as ornament pre-form.

Hawes Mixed Upper Zone. Twnety-six pieces of modified bone were recovered from the first four levels at 41WM56, Areas B and C. These levels were greatly disturbed by agriculture resulting in a mixture of Late Archaic materials. The site is clearly an intensively and repeatedly occupied campsite with an abundance of vertebrate food remains and a correspondingly abundant bone tool assemblage. Deer ulnae and metatarsals provided much of the recognizable raw material, and it is highly likely that the fragmentary tools were also made from deer long bones. Nearly all classes of tools are represented except flaked pieces and bifurcate pointed tools.

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks

Base deer ulna 1733 41WM56-C 6.4 unburned; tip missing; posterior edge of shaft has been cut away at an angle possibly in an attempt to constrict the broken working end for reshaping; although poorly preserved, a light polish is still visible on broken end (Fig.14.7-3c).

Base deer metatarsal 848 41WM56-C 5.7 unburned; proximal anterior portion with groove present, marrow cavity area completely smoothed; triangular in cross-section; tip missing, light polish visible on broken end, longitudinal fabrication cuts visible in proximal end of groove and along marrow cavity; longitudinal use striations are present on shaft; one transverse cut on proximal end.

Base deer metapodial 780 41WM56-C 2.4 burned proximal portion; element split longitudinally to obtain lateral or medial portion for tool manufacture; longitudinal fabrication cuts are present in marrow cavity; light polish visible near breakline; transverse break appears to have occurred from using lateral pressure on tool.

Base deer metatarsal 940 41WM56-C 6.3 unburned proximal end; charred distal break; lateral portion split longitudinally; anterior groove present with deep fabrication cuts.

IB deer ulna 1036 41WM56-C 7.2 unburned shaft and tip; base broken; blunt, flat tip is similar to ulna flakers as described by Olsen and Wheeler (1978) and Olsen (1979); curving longitudinal scratches on shaft; light nicks on tip; polish not apparent because of surface deterioration (Fig. 14.7-3d).

IB fragment 348 41WM56-B 2.5 unburned tip; moderately polished; long, wide groove incised by multiple longitudinal cuts on one side with transverse cuts across groove; more transverse cuts on opposite side (Fig. 14.7-3e).

IIB	3 fragments	344,	41WM56-C	2.9	unburned
		1070,	41WM56-C	1.2	unburned
		1561	41WM56-E	2.0	burned tip;

#344 may be broken tip of ulna tool with sharply angled taper to a semi-blunt tip. #1561 also has sharply angled taper but ends with a pointed tip (Fig. 14.7-3f,g).

IIB fragment 1321 41WM56-B 2.8 unburned tip; made from spirally fractured fragment with edges worn smooth; rounded and lightly polished; tip is constricted which may have resulted from rodent gnawing.

IIB	3 fragments	751	41WM56-C	0.6	burned; tiny sharp tip
		1731, 1732	41WM56-C	4.1, 2.3	both unburned tips;

all have a gradual taper to a sharp conical point; #1731 has highly polished tip.

IIB 4 fragments 1478 41WM56-D 1.7 burned shaft;
930 41WM56-C 1.5 burned shaft;
1293 41WM56-C 2.0 burned shaft;
1740 41WM56-E 1.8 burned shaft;
all are similar in manufacture and wear; highly polished and covered with longitudinal striations; #1293 and #1740 are extremely similar in diameter and degree of burning, do not articulate, and come from different excavation areas at the site.

IIB 2 fragments 898 41WM56-C 3.2 charred shaft;
1592 41WM56-E 1.4 charred shaft;
both are broken lengthwise and show traces of wear and polish.

IV deer antler 1141 41WM56-C 1.0 burned tip; made from sliver of antler, triangulate tip is smoothed and rounded; faint oblique striations near tip.

IV fragment 1561 41WM56-2 2.2 unburned tip; made from deer-size long bone wall; edges left unsmoothed; only tip shows wear; poor condition.

V deer antler 342 41WM56-C 1.7 burned ornament fragment; antler tine cut transversely and split longitudinally with small hole drilled (?) in center of one end; interior is concave with smoothed edges; end opposite hole has old and recent breaks perhaps damaged during manufacture since hole lacks abrasion from wear.

V fragment 1326 41WM56-C 1.0
(Fea. 6) unburned tubular bead; made by ring and snap technique.

VI artiodactyl
tibia 1729 41WM56-C 7.5 unburned fragment of shaft wall; one end spirally fractured; opposite end flaked to form blunt point; tip and one edge have light polish (Fig. 14.7-2c).

VII 2 artiodactyl
metapodials 34,112 41WM53-A 1.7, 3.1 unburned fragments with similar fabrication cuts.

<u>NeoAmerican</u>. Nine bone artifacts, mostly fragmentary, were recovered from uppermost strata at two Granger sites (41WM230 and 258) and two North Fork sites (41WM53 and 404). Both Austin and Toyah components are included, sometimes mixed. Basically the types of bone tools, their shapes and manufacture do not differ from Archaic assemblages. Ulna tools and conical tips are present as well as thin and narrow shaft fragments. Both flaked and utilized spiral fractures are recorded as well.

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks
Base	deer ulna	1326	41WM230-E (Austin)	--	see Prewitt, this volume; specimen # 1491.
IB	deer ulna	1704	41WM230-E (Toyah)	--	see Prewitt, this volume; specimen # 2762.
IIA	canid(?) ulna	153	41WM404-R	3.8	burned shaft fragment; although heavily coated with mineral deposit, longitudinal striations and polish are visible on the surface.
IIA	fragment	2567	41WM230-5 (Fea. 61)	0.5	charred; small, delicate tip; less than 1.5 mm diameter of broken end; recovery of this tiny artifact fragment is attributable to fine screening and sorting procedures (Fig. 14.7-5g).
IIA	fragment	20	41WM258-A	4.4	unburned slender tip reworked into microtool; newer fabrication scars and incomplete smoothing of end opposite tip; lightly polished tip; surface covered by faint longitudinal striations.
IIB	fragment	22	41WM258-A	2.3	burned shaft fragment; thin (2.8 mm), but not as narrow as others (11.9 mm); it is completely smoothed with a deep broad groove down the center of each side forming figure eight cross-section; lightly polished; many longitudinal striations.
IIB	fragment	236	41WM404-A	2.5	burned shaft fragment; thin (1.9 mm) and narrow (8.2 mm); no polish; faint oblique cuts near one edge; probably broke early in use and subsequently discarded.
IV	artiodactyl	29	41WM53-A	10.4	unburned possible tool; made from spirally fractured long bone fragment, all broken edges are smoothed but poor condition prohibits verification of use.
VI	fragment	537	41WM230-3	2.8	unburned flaked fragment; no indication of wear.

Backhoe Trenches. Nine of the most complete bone tools recovered during San Gabriel excavations are recorded from the backhoe trenches. Surficially the bones are similar to the total faunal collection being pitted, root etched, and gnawed. It is their unbroken state that is

impressive. Only three artifacts are broken and these are basal breaks that may have terminated the use of the tool. All of the others are complete as manufactured. All are unburned. Two-thirds of these bone tools come from the Hawes Site (41WM56) and the adjacent (41WM57). The remaining three tools come from Cervenka (41WM267) and Bryan-Fox Sites (41WM124).

Class	Species/Element	Cat. #	Site	Length(cm)	Remarks
Base	artiodactyl metapodial	5	41WM57-0	7.9	unburned, unfinished tool; made from longitudinally split lateral or medial portion; smoothed proximal end serves as base; only base shows fabrication scares; spirally fractured and possibly flaked tip appears unused.
IB	deer ulna	1714	41WM56-0	7.3	unburned; proximal end damaged; length of working end (from radial notch to top) is 3.8 cm; tip broken medially leaving small scar; too poorly preserved to detect wear.
IIA	artiodactyl	1715	41WM56-0	10.1	unburned complete tool; made from spirally fractured, long bone wall fragment; one end completely smoothed and shaped to sub-conical tip; transverse striations on tip (Fig. 14.7-2d).
IIA	fragment	175	41WM124-0 (Early Archaic)	7.8	unburned; long, slender tip is highly polished at point; longitudinal striations on shaft; tip was removed from original base by groove and snap technique as exhibited by transverse cuts and constricted breakline.
IIA	artiodactyl metatarsal	199a	41WM267-X	13.4	unburned shaft; small portion of tip broken during excavation and unrecovered; basal portion broken prior to recovery; made from longitudinally split, lateral or medial fragment; anterior groove present along one edge; tip is constricted midway down the shaft and again 1.0 cm from the end; light polish evident although badly gnawed.
IIA	fragment	199b	41WM267-X	9.2	unburned tubular shaft and tip; marrow cavity visible near tip where wall has been thinly abraded; although surface is badly pitted, polish is visible near tip and longitudinal striations are found on shaft which ends in old break.

IV artiodactyl 1716 41WM56-0 7.3 unburned complete tool; made from spirally fractured, long bone wall fragment; all edges are fairly smooth, highly polished triangulate tip; small depression on raw edge about 2 cm from tip is also polished and discolored; light longitudinal striations are visible on opposite edge near tip perhaps as result of pressure exerted on depression (Fig. 14.7-2e).

VII 2 fragments 10, 12 41WM57-0 2.9, 7.0 both unburned, double-pointed tools; spirally fractured, long bone wall fragments; tips of smaller one appear to have been flaked but unused; both ends of larger fragment are shaped, but only slightly polished.

VI. RESULTS OF ENVIRONMENTAL STUDIES

The research reported here was conceived and conducted as a multi-disciplinary project. Modern archaeology relies on input from specialists from other disciplines to provide data on various topics such as environmental reconstruction, subsistence strategies, and raw material sources. These data become an integral part of archaeological interpretation of past human behavior patterns. To emphasize the importance of these studies, individual articles are included in the body of the report rather than as appendices. The data bases for the various studies, however, are found in the appendices.

15.0 Paleoenvironmental Reconstruction

15.1 Introduction

by

Stephen A. Hall

Prehistoric environmental conditions are determined largely from paleontological evidence, particularly pollen, vertebrates, and mollusks. Paleontologic studies of sediments dating from the last 2,000 years in the Southern Plains, a time period of archaeologic interest in this report, are disappointingly few.

Pollen

Six postglacial spring marshes within 150 km of North Fork Reservoir have been investigated by pollen analyses (Potzger and Thorp 1943, 1947, 1954; Graham and Heimsch 1960; Larson and others 1972). Only two of the pollen sequences are radiocarbon dated. The base of Soefje Bog in Gonzales County is dated to 7,800 years ago (Graham and Heimsch 1960). About 2km south of Soefje Bog, three intervals of Hershop Bog are radiocarbon dated at 2,000, 6,000, and 10,600 years ago (Larson and others 1972). The upper 0.8 meters of Hershop Bog that includes the interval from which the 2,000 year date was obtained is unfortunately barren of pollen. Boriack Bog contains pollen to its surface; however, the upper part of the peat has been mined and burned. The youngest radiocarbon date is 3,700 years ago from 40 to 50cm depth (Bryant 1977). As a result, none of the published pollen studies from central Texas can be related to the complete stratigraphic or archaeologic sequence at the North Fork and Granger Reservoirs beyond the broad generalization that, during the past 10,000 years no great changes have occurred in the vegetation except for a gradual, continual decrease in trees. Mid-Holocene altithermal aridity is not recorded in these central Texas pollen sequences.

Mollusks

Land snails and freshwater snails and clams occur throughout the alluvium exposed along the North Fork Valley. A concentration of shells in the clay immediately above the basal gravel bed at section G-6 includes *Helisoma*, *Gyraulus*, at least two other aquatic snails, the freshwater pill clams *Sphaerium* and *Pisidium*, a unionid, and the land snails *Rabdotus* and *Helicina*. Shells were not collected, but are sufficiently abundant for radiocarbon dating and paleoecologic study.

The nearest reported Holocene molluscan fauna comes from Stillhouse Hollow along the Lampasas River (Cheatum and Slaughter 1966). The shells occur about two meters below the horizon radiocarbon dated about 5,000 years ago. The faunule includes, among others, the cool climate species Cionella lubrica and the eastern species Pomatiopsis lapidaria, suggesting an early postglacial age.

Two younger molluscan assemblages from north Texas, a channel fill along the Sulphur River in Delta County dated 1,800 (on shell) and 1,100 and 1,200 years ago (on charcoal) (Cheatum and Allen 1965: 9-10) and the Gus Thomasson Road faunule from the Trinity River in Dallas County estimated about 1,000 years old (Willimon 1972), are composed of essentially the modern fauna without any of the northern forms such as occur in the Stillhouse Hollow faunule. By 1,000 years ago, such as with the vertebrates, the character of the modern molluscan fauna, both terrestrial and aquatic, was established.

Vertebrates

Fossil vertebrate studies from late Pleistocene and Holocene cave and alluvial deposits in central Texas are summarized by Lundelius (1967) who concludes that, for the most part, the species composition of modern fauna was attained around 1,000 years ago. Prior to that time to about 8,000 years ago, the Texas vertebrate fauna included several species that occur today to the north and east of central Texas. In agreement with the pollen record, the vertebrates provide no evidence of a post glacial "altithermal" warmer or drier climate (Lundelius 1967).

In contrast to this general picture, a vertebrate fauna from Montague County in north Texas contains two small mammals, the Merriam pocket mouse (Perognathus merriami) and the northern grasshopper mouse (Onychomys leucogaster), that today occur only beyond 150 km west of the fossil locality. Charcoal from the site is dated 1,350 $\pm$ 150 B.P. (M-845). The implication of the past eastern expansion of the ranges of these two species is that the climate was more arid at that time and has since become more mesic (Dalquest and Hibbard 1965). On the other hand, the Kyle archaeological site in Hill County (Jelks 1962; Lundelius 1967) is today east of the modern range of O. leucogaster (Burt and Grossenheider 1964) and contains the species in both the 1,000-1,400 and 400-700 years ago levels. These facts suggest recent shifts in the ranges of some species. Whether the shifts are related to changes in climate or some other factors is not known.

15.2 Macrobotanical Analysis

by

Cathy Crane

Identification of plant remains recovered from archaeological sites can often provide valuable information about plant utilization and the season or seasons the site was occupied. Plant remains may also be used as indicators of the local ecological conditions during the time of prehistoric utilization.

Methodology

The density of preserved plant remains in the open sites of central Texas is relatively low, and a majority of these remains are extremely small and are most easily recovered by the use of a flotation method. During excavation of the San Gabriel sites matrix (flotation) samples were taken from the northwest quad of each 10cm level, and additional samples were taken from features. All of these samples were subjected to flotation and analyzed.

A water flotation method similar to that advocated by Bohrer and Adams (1977:37) was used to separate the plant remains from the soil matrix. In this method the soil was poured through an 1/8" mesh screen into a dishpan filled with water. The heavy fraction and large plant remains were caught by the screen. The mud in the dishpan was stirred by hand and allowed to settle for no more than a minute, and then the water was poured off into a .5 millimeter mesh geological sieve leaving the sand or clay residue in the bottom of the dishpan. The pan was filled again with fresh water, and the stirring-and-pouring-off process was repeated one or more times until all visible charred plant remains had been extracted from the mud. The plant remains collected in the geological sieve were placed on newspaper to dry.

In order to make the sorting of seeds from charcoal easier, the dried plant remains were passed through three graduated geological sieves (4mm, 2mm and .5mm mesh). Each particle size was sorted under a binocular dissecting microscope at 5X magnification, and identification was made by reference to seed manuals such as Martin and Barkley (1961), Musil (1963) and US Department of Agriculture Handbook No. 450 (1974). When possible, comparisons were also made with modern seeds.

Seeds were identified to genus level and counted. Nutshell fragments and nut kernel fragments were also identified to genus and counted to give an idea of the quantity present in each sample. All unidentifiable seeds were counted and recorded as undetermined disseminules (see Appendix B). The type of trees represented by the wood charcoal were not identified.

In the San Gabriel sites only those seeds and other plant parts which were accidentally or deliberately burned are likely to be preserved since charcoal is largely mineral and more resistant to decay by decomposers (Evans 1978:25). Therefore, all uncharred seeds found in the samples are probably modern contaminants, but they were also identified and recorded.

North Fork Reservoir Sites

All of the plants represented in the North Fork flotation samples can be found in the area today. North Fork Reservoir is located within the Balcones Escarpment which supports a grass understory with cedar (*Juniperus ashei*), oak (*Quercus* spp.), and mesquite (*Prosopis juliflora*) forming the overstory. Other trees in the area include pecan (*Carya illinoensis*), hackberry (*Celtis reticulata*), walnut (*Juglans nigra*), willow (*Salix* spp.), and elm (*Ulmus alata*).

The most common plant remains preserved in the sites of all time periods at North Fork are charred acorn fragments (*Quercus* spp.). However, a majority of these fragments are quite small; and, as a result, it is impossible to estimate the number of acorns represented or the species used. The acorns of black oaks are generally bitter and inedible unless the tannic acid has been removed. White oak acorns are usually less bitter, but palatability may very greatly between trees of the same species in the same locality (Renfrew, 1973:155). Some groups such as the Algonkians removed the tannin by soaking acorn meal in hot ash lye water (Yarnell, 1964:70). At North Fork the abundance of charred acorn remains suggests that the people roasted the nuts, and then they may have ground them and leached the meal.

The plant remains recovered from each of the North Fork sites are discussed below.

41WM73

This site is a burned rock midden of the Early to Middle Archaic period. The predominance of charred acorn remains recovered from this site indicated that at least one function of the burned rock midden was to roast acorns. The heaviest concentrations of acorns are in the lower levels of the midden, but leaching may have washed some of the remains downward through the midden.

The only other charred plant remains found in the midden were a few small seeds too fragmentary to be identified. The uncharred hackberry (*Celtis* sp.) and juniper seeds (*Juniperus* sp.) are modern contaminants. Overall this site has less diversity in plant remains than the other North Fork sites.

41WM56 (Hawes Site)

The best indication of plant utilization at this multi-component site was recovered from Feature 6, a fire hearth, which contained a large amount of plant remains including several charred prickly pear cactus seeds (Opuntia sp.). Although the seeds were often discarded while preparing the prickly pear fruits, some groups such as the Diegueno regularly parched and ground the seeds (Bohrer, 1970:414). The uncharred amaranth seeds found in Feature 6 are assumed to be modern contaminants. However, there were also a few charred amaranth or chenopodium seeds within the Feature. These seeds are listed as Cheno-am because the seeds of Amaranthus sp. and Chenopodium sp. tend to become distorted when they are parched; and, as a result, they cannot be accurately distinguished from each other. Other charred plant remains recovered from Feature 6 include acorn fragments and possibly some pecan nutshell (Carya sp.). However, the identification of pecan is tentative since the remains are quite fragmentary.

A small quantity of charred acorn fragments were also found in some of the other units, and one charred walnut nutshell (Juglans sp.) was recovered in the vicinity of Feature 8. A charred juniper seed (Juniperus sp.) from level 3 of 1063N1097W suggests that the people may have been utilizing juniper berries and/or burning the cedar branches for fuel. Feature 11 contained a large amount of wood charcoal, but no seeds. The tree genera represented in this feature have not been identified.

41WM57

This Middle Archaic site is located next to 41WM56, but only a small quantity of plant remains were recovered from the flotation samples. Feature 5 contained one charred juniper seed and two acorn fragments. While Features 6 and 7 each had a small amount of acorn fragments, there are possibly a few pecan fragments from Feature 7.

41WM53

Overall the density of charred plant remains recovered from this multi-component site is low; however, some valuable information was obtained. Feature 4, a large fire hearth, yielded only a samll quantity of charred acorn fragments, a charred Aster sp. seed, and one charred Compositae (Sunflower family) seed which could not be identified to genus. Uncharred seeds from copperleaf (Acalypha sp.), verbena (Verbena sp.), spurge (Euphorbia sp.), and witchgrass (Panicum sp.) were also recovered from the Feature 4 samples, but they are all modern contaminants.

Feature 6 contained acorn fragments, a charred hedgehog cactus seed (Echinocerus sp.), and a charred Compositae seed which was too distorted to be positively identified to genus level. However, it is certain that this Compositae seed and the one from Feature 4 are not sunflower seeds

(Helianthus sp.). A charred Cheno-am seed and another charred seed, which could not be identified, were found in the level above this feature. Area B of Feature 3 yielded one charred Cheno-am seed, acorn fragments, and charred seed fragment which was unidentifiable.

41WM304

No charred plant remains of any type were recovered from this burned rock midden.

41WM328

Good evidence of the utilization of several types of nuts were recovered from this Terminal Archaic site. Feature 2 appears to have been a large hearth which was used to roast acorns (Quercus sp.), walnuts (Juglans sp.), and pecans (Carya sp.). Since these nuts are available at approximately the same time in the fall, it is not surprising that the inhabitants appear to have collected and processed them simultaneously.

Feature 17 also contained a large quantity of acorn and pecan fragments, and the levels immediately above this had additional amounts of acorn and a few charred hedgehog cactus seeds (Echinocerus sp.). The samples from the upper levels of this site were heavily contaminated with copperleaf seeds (Acalypha sp.) and some hackberry seeds (Celtis sp.). One charred grass seed (Panicum sp.) was found in Feature 3, but the association may be spurious.

Granger Reservoir Sites

The Granger Reservoir area is part of the Blackland Prairie of the West Gulf Coastal Plain, and generally the types of plant remains recovered from the Granger sites are quite different from those in North Fork. Although acorn fragments are also found in the Granger sites, other plant remains which are rare or absent in the North Fork sites are prevalent in the Granger samples. These plant remains include various types of grass grains, sunflower seeds, dock seeds, and pokeberry seeds. With the possible exception of some of the grasses which may have been removed by overgrazing or farming, all of these plants are common on the modern Blackland Prairie.

41WM230 (Loeve-Fox Site)

The best information on plant utilization in the Granger Reservoir area was obtained during the 1978 excavations at this alluvial terrace site which spans the Early Archaic to Post-Archaic time periods. Flotation samples were taken only from features.

Feature 40 at Loeve-Fox contained a diversity of charred plant remains, but all are in low quantities. These include acorn fragments, a grape seed (Vitis sp.), a dock seed (Rumex sp.), and a loco weed seed (Astragalus sp.). The occurrence of the charred dock and loco weed seeds may be fortuitous, but they were occasionally found in other samples from Loeve-Fox and other Granger sites. Two different species of Panicum sp. grass grains (one of these is probably vine-mesquite or witchgrass) were also recovered from Feature 40, and another grain fragment is tentatively identified as wildrice (Zizania sp.).

Fragments of two charred sunflower seeds (Helianthus sp.) were recovered from Feature 67, but these are from a non-cultivated variety of sunflower. Another charred seed from Feature 67 is identified as peppervine (Ampelopsis sp.) but may possibly belong to the closely related Vitis sp. (grape). However, if it is a grape seed, it is from a different species than the grape seed recovered from Feature 40. One Panicum sp. grass grain was also found in Feature 67.

Charred acorn fragments and fragments of Elymus sp. (Canadian wild-rye) grains were found in Feature 70, and Feature 49 also contained acorn fragments and one Stipa sp. (needlegrass) seed. Feature 47 contained a charred hackberry seed (Celtis sp.). Of the dozens of hackberry seeds recovered from the San Gabriel sites, this is the only one which does not appear to be a modern contaminant. The burning of this seed may have been accidental, but it is possible that the people may have utilized the berries. Hackberries were collected by the Sauk-Fox Indians, and charred hackberry seeds have been found in archaeological sites such as the McGraw Hopewell site in Ohio (Yarnell, 1964:72).

Charred Rumex sp. seeds were found in Features 45, 69, and 54; and a charred pokeberry seed (Phytolacca sp.) was recovered from Feature 69. Feature 102 contained one loco weed seed (Astragalus sp.) and an Elymus sp. grass grain, and Feature 100 had one charred ragweed seed (Ambrosia sp.) and unidentifiable grass grain fragments.

Overall the most common plant parts found in the Loeve-Fox samples were charred grass grains. Features 31, 40, 41, 51, 54, 64, 67, 70, 71, 72, 88, 89, 100, 102, 104, and 106 all contained grass grains, but none had more than a few grains. As a result, it could be suggested that these all represent accidental burnings since the grains are extremely small and could have been easily collected with the firewood, and/or it is possible that the people may have periodically burned-off the prairie. On the other hand, it can be argued that the collecting of grass grains may have played an important part in the peoples' economy, particularly if they were utilizing such grasses as Elymus sp. (wild-rye) and Stipa sp. (needlegrass). These are cool-season grasses, which means that they start growing during the warm days of late winter and early spring and are ready to harvest by early summer. According to Bohrer (1975:199), this was a critical time of the year for farmers and hunters-gathers since the stored foods were

almost depleted, and the new crops were immature.

> The cool-season grass grain provides a ready source of abundant calories that can be immediately consumed and also stored. Harvested grain bridges the growing season until the first of the wild fruits mature in the summer (Bohrer, 1975:199).

Stipa neomexicana was utilized by the inhabitants of Fresnal Shelter, New Mexico (Bohrer, 1975:202), and the Paiute collected *Stipa speciosa* (Steward, 1933:243) and *Elymus canadensis* (Chamberlin, 1911:369).

A majority of the grass grains recovered from the Granger sites appear to belong to the *Stipa*, *Elymus*, and *Panicum* genera. However, the identification of these grains to genus level is difficult since there are a large number of genera and species in the *Gramineae* family with considerable overlapping in the seed characteristics of the different tribes and genera. Identification is further complicated by the distortion caused by the cultural practice of parching the seeds and by the fact that some of the grains are naked and others are still enclosed in their floral bracts (called the palea dna lemma). As a result, some of the grass grains could not be positively identified to genus and were listed as unidentified *Graminae*.

41WM124 (Brian Fox Site)

This is an alluvial terrace site of the Late to Terminal Archaic periods, and levels 27-28 of unit 801N/803W contained the best preserved examples of charred acorns recovered from any of the San Gabriel sites. These acorn fragments include fourteen entire kernels (or cotyledons). However, the oak species of these acorns could not be determined since the cups are missing and the nutshell distorted by the heat.

Several fragments of charred grass seeds were also recovered from this site, but most could not be identified to genus. However, a few complete grains of *Elymus* sp. and *Stipa* sp. were identified. The only other charred plant remain recovered from Brian Fox was one Cheno-am seed.

41WM267 (Cervenka Site)

Preservation at this Early to Late Archaic site is extremely poor, and from the dozens of flotation samples taken, only a few charred seeds were recovered. These include a Cheno-am seed, two *Sporobolus* sp. (dropseed) seeds, a *Rumex* sp. (dock seed), an *Ambrosia* sp. (ragweed) seed, and a *Helianthus* sp. (sunflower) seed fragment.

41WM258 (Bigon-Kubala)

The plant remains from this Late Archaic to Neo-American site are consistent with those of the other Granger sites. Unit 976N.956W contained a good quantity of charred acorn fragments and several charred *Sporobolus* sp. seeds. Charred sunflower seeds were also recovered from Bigon-Kubala, and some pecan fragments (*Carya* sp.) were found in the upper levels of this site.

Conclusion

For the San Gabriel sites flotation offers the only significant means for recovering prehistoric botanical remains, and the major value of these remains is in providing dietary information. However, such plant remains constitute only a partial inventory of the prehistoric diet. In particular they represent foods that were accidentally burned during preparation and possibly building materials burned in structural fires. Uncharred plant parts including seeds, greens, and tubers are unlikely to be preserved in the open sites of central Texas.

Because of this differential preservation, statements about the overall importance of a particular plant cannot be made. For instance, the flotation data suggests that acorns played an important role in the economy of the North Fork inhabitants, but it is possible that other plants, such as prickly pear and chenopodium were just as important. It is significant, however, that no domesticated plant remains were recovered from the San Gabriel sites which strongly suggests that the inhabitants were strictly hunters and gatherers. This type of subsistence was reflected by the early historic inhabitants of the area, the Tonkawas, who had an economy based on hunting, gathering, and fishing (Newcomb, 1969: 135, 138-141).

Plant remains recovered by flotation may also provide information about the season(s) of the occupation of a site. Most of the remains at the San Gabriel sites indicate a late summer (i.e., sunflower, amaranth, panicum grass) to late fall (i.e., acorns, walnuts, pecans) occupation. Early summer occupation of some of the Granger sites is suggested by the presence of "cool season" grasses. However, it is stressed that the inhabitants most likely stored nuts and seeds for winter and spring use; and, therefore, the presence of these foods does not always reflect a summer-fall occupation. Faunal material found in association with plant remains can often be used to strengthen interpretation of seasonality. In other words, seasonality based solely on plant remains will probably remain something that can be strongly suggested, but not often conclusively proven.

Finally, plant remains combined with pollen and faunal analysis provide a means for studying the prehistoric ecology of a site. At San Gabriel,

the plant remains recovered by flotation are all present in the area today. It is interesting that there is a contrast between the North Fork and Granger plant remains which strongly suggests that the modern Oak-Cedar Woodland versus Blackland Prairie dichotomy also existed prehistorically.

15.3 Geology of Selected Archaeological Sites

by

Stephen A. Hall

North Fork Reservoir Sites

Site 41WM53

This site occurs in the upper part of a thick alluvial clay of a natural levee. A paleosol is developed in the upper 100cm of the alluvium. The dark gray color of the paleosol at the site is probably accentuated by increased organics including charcoal resulting from the prehistoric occupation. The large stones associated with the site were brought in by prehistoric man and are not a natural feature of the fine-grained alluvium.

Barker Site (41WM71)

Archaeological materials occur in the paleosol and below the paleosol in medium brown silty clay terrace alluvium. The terrace surface is 8.1 meters above the North Fork channel. The stratigraphy exposed at this site is similar to that at other localities on the North Fork. Faint carbonate films occur in the silty clay below the paleosol. Aquatic snails, Helisoma, Gyraulus, and Physa, also occur in the clay. A thick gravel layer underlies the clay and rests directly on Cretaceous limestone.

Site 41WM73

This site is a burned rock midden located on the North Fork terrace immediately adjacent to the hillslope rising above the terrace surface. The terrace alluvium below the midden is a light to medium brown clay, 195 to over 285 cm depth containing scattered limestone gravels generally less than 5 cm in diameter. From 125 to 195 cm depth a medium brown clay with wavy land snails occurs. The transition from this clay to the archaeological midden is gradual. The principal part of the midden extends from about 10 to 125 cm depth and consists of burned limestone rocks 5 to 10 cm in diameter with a dark grayish brown clay matrix. The midden is overlain by 10 to as much as 45 cm of colluvial clay and limestone gravel. The limestone gravels are angular and less than 5 cm in diameter. The archaeological midden zone is thus distinguishable from the non-archaeologic sediment below and above by the presence of larger limestone gravels and darker clay matrix.

Granger Reservoir Sites

Site 41WM122

This site occurs in terrace alluvium. The terrace surface is 7.9 meters above stream level. Exposed at base of stream bank is Cretaceous marl; above the marl is a zone of gravels, then light to medium brown silty clay, and at the top of the terrace deposit, medium dark brown clay. Land snails are scattered throughout the clay. Thin carbonate films are present in the light brown clay. Archaeological materials, mainly thin lenses of burned rock layers, occur in the light brown silty clay middle unit.

Bryan Fox Site (41WM124)

Archaeological remains at this site occur in terrace alluvium similar to other sites along the San Gabriel River. In a trench excavated through the site and the nearby stream cut-bank are exposed four stratigraphic units: limestone gravel at the base extending down to stream level; light brown silty clay containing carbonate nodules; medium brown silty clay; and at the top a dark gray clay (probably a paleosol) containing land snails and archaeological remains.

Site 41WM163

This site is situated in terrace alluvium that forms a surface 8.9 meters above the stream level. The terrace geomorphology differs from that at other localities along the San Gabriel River. A well developed lower terrace surface occurs at 2.5 meters above stream level, 6.4 meters below the broader and more extensive 9 meter terrace (Fig. 8.8-1). No sand or gravel were seen in the archaeologic excavations down to 3.2 meters depth.

Cervenka Site (41WM267)

This site is unusual in that it is situated on the terrace margin far from the present San Gabriel River channel. Field inspection shows, however, the presence of an abandoned partially filled prehistoric channel near the Cervenka Site. This filled channel may have been the active river channel when the site was occupied. All the other sites in the area were probably located near the river banks in the past, resulting in consistent pattern of site distribution.

The edge of the site is against a hill composed of coarse limestone gravels. A partly eroded paleosol occurs at the top of the gravels. The paleosol contains calcium carbonate concretions up to 5 mm in diameter. Some of the gravels below the paleosol are cemented by calcite. The gravels and probably the paleosol, are Pleistocene in age and pre-date the prehistoric occupation of the area. These gravels are exposed at the site in a small quarry. A hole for water was dug into the floor of the quarry; Cretaceous marl was encountered at about three meters depth. Nearby excavations at the site extended to greater than seven meters depth and did not expose the marl (Fig. 8.10-1).

The archaeological remains at the Cervenka Site occur in fine grain alluvial fill that lacks distinguishing stratigraphic features, resulting in an inability to define or trace units from one area of the site to another. The eastern edge of the site is eroded by a small gully. Gravel, reworked from the adjacent Pleistocene terrace, and clay deposits border the gully, and colluvial materials, including reworked Pleistocene gravel, mantle portions of the site masking and obliterating the old terrace surface. Because of the partial erosion and colluvial cover, the site appears different from all the other sites along the San Gabriel River. However, these differences are superficial. Prehistoric occupation of this locality continued throughout the mid and late Holocene, while at the same time alluvial aggradation buried each living horizon deeper and deeper.

Summary

The North Fork landscape is dominated by thick-bedded Cretaceous limestone that, upon weathering and erosion, results in deep narrow valleys. In contrast, the Granger Reservoir area has low relief and broad valleys. These differences in appearance of North Fork and San Gabriel River Valleys, however, mask their similar recent geologic history. Prior to mid-Holocene time, probably during the late Pleistocene, the North Fork and San Gabriel River Valleys were deeply eroded, isolating fluvial gravels as a terrace in the Granger area. By 5,000 years ago, and perhaps as early as 7,000 years ago, the North Fork and San Gabriel Rivers began to aggrade somewhat rapidly at an estimated rate of around 15 to 25 cm per century. During the past 5,000 years, while the river valleys were filled with fine grain overbank clay and silt, the river banks were the sites of prehistoric camps. Some localities were preferred over others; thus, throughout the late Holocene, successive prehistoric occupations at one place were buried deeper and deeper by continued alluviation.

The exact duration of the period of alluviation is not clear. However, the stratigraphic evidence suggests that by 1,300 years ago valley filling had diminished. In the North Fork Reservoir area, a paleosol A-horizon has developed at the top of the fine grained alluvium. Some archaeological remains occur in this paleosol. At Granger Reservoir, the paleosol is missing or, when present, not as well developed or as persistent as at North Fork. Also, in the Granger area, two thick zones of medium gray brown clay occur in several of the alluvial sequences exposed at archaeologic sites. These gray zones may be weakly developed paleosols, or at least may reflect increased organic matter content due to a slowing rate in the rate of overbank sedimentation. These buried gray zones were not seen in the North Fork area.

At some sites, such as Loeve-Fox, the exposed alluvium shows thin zones and units that can be traced only a few meters or 10's of meters. These stratigraphic features probably have little regional significance and only reflect the local irregular surface of the floodplain at different times during Holocene valley filling.

The North Fork and San Gabriel River Valleys were trenched sometime between 500 and 1,500 years ago. The former floodplain, built up continuously for several thousand years, was left as a terrace surface 7 - 9 meters above the present stream level.

The paleoecologic history of the region is not sufficiently detailed to serve as a climatic framework with which to compare the geologic historys. Attempts to analyze pollen from the Holocene alluvium failed (Chapter 15.4).

15.4 Pollen Studies At Granger Reservoir

by

Stephen A. Hall

Introduction

Sediment samples from the Loeve-Fox and Cervenka Sites were processed for pollen content. None of the samples contained sufficient numbers of pollen grains for analysis (Table 8.3-1). In another study at Granger Reservoir, Vaughn Bryant (1977) was unsuccessful in recovering pollen from the Centerline Site (41WM21). The absence and poor preservation of pollen in alluvial sediments from Centerline, Cervenka, and Loeve-Fox sites may be due to the destruction of pollen on soil surfaces in the drainage basin. Surface materials may be the principal contributor of pollen to fluvial sediments. Surface deterioration of pollen eliminates surficial materials as a pollen source to alluvium. An investigation by Dering, Bryant, and Weir (19) was initiated to show the relationship between modern surface pollen and modern plant communities in the Granger and North Fork Reservoir Districts. An unexpected result was the absence of pollen at 10 of 16 surface stations. Also, pollen preservation at the six pollen-bearing localities was exceedingly poor. Furthermore, the six pollen assemblages are most likely altered and of little ecologic application. Pollen counts from the six stations (two in Granger area and four in North Fork area) contain 8 to 39% pine with an average of 25% pine. Pine trees do not occur in the area today. A regional study of modern pollen and vegetation on the Edwards Plateau (where pollen preservation in surficial materials is evidently better than at Granger-North Fork) shows that pine pollen frequencies range from zero to 10% and average 6%, all from non-pine communities (Shaw, Volman, and Smeins, 1980). In a review of pollen preservation (Hall, 1981) it was concluded that pine pollen is more resistant to destruction than other pollen types. Thus, the high pine pollen frequencies found by Dering *et al*. (19) at Granger-North Fork surface materials probably reflect an advanced state of deterioration, thereby resulting in alteration of the pollen assemblage. If differential destruction of pollen grains has occurred, as indicated by the high pine counts, pollen analysis of sediments from sites in the Granger Reservoir area will be affected and will not be of any use for interpretation of past vegetation and climate. Because of the negative results from sites and surficial materials, pollen investigations were not expanded to other sites in the project area.

Cervenka Site (41WM267)

Nine samples were collected by Duane Peter in 40cm intervals from 98.40 (top) to 95.20 meters (bottom) levels. In collaboration with

Vaughn Bryant at Texas A&M University, these nine samples were taken to Exxon Research Laboratories, Houston, where they were processed by Jack Bruce using special laboratory techniques developed at Exxon. As a check, Lycopodium spores were added to each sample. The samples were processed by concentrated HF, sonicator treatment, and heavy liquid separation. Residues from all of the samples contained introduced Lycopodium spores, but no pollen.

Loeve-Fox Site (41WM230)

One pilot sample was collected from the horizon of an excavated hearth exposed near the base of a deep gully cut through the northern margin of the site. The sample was processed by standard techniques that have proved successful at other sites: HCl, HF, heavy liquid separation, and acetolysis. Numerous Lycopodium spores were recovered in the residue. A few pollen grains were observed. However, several Cretaceous spores and dinoflagellates (marine algae) were also seen in the residue. These microfossils are reworked from the Cretaceous rocks that outcrop in the San Gabriel drainage basin. A grain count was not made. The low number of pollen grains compared to the larger number of introduced Lycopodium spores suggests, however, that the pollen concentration is too low to be regarded as sufficient for reliable analysis.

TABLE 15.4-1

Pollen data, Granger Reservoir

Site 41WM267, Cervenka Site	
98.40 m (top)	No pollen; Lycopodium spores, many fungal bodies, large amount of charcoal.
98.00	No pollen; (ditto), not as many charcoal fragments as above.
97.60	One pollen grain observed; Lycopodium spores fungal bodies, some charcoal.
97.20	One pollen grain seen; Lycopodium spores, some fungal bodies, little else.
96.80	No pollen; Lycopodium spores, a few charcoal fragments.
96.40	No pollen; Lycopodium spores, a few charcoal fragments.
96.00	No pollen; Lycopodium spores, a few charcoal fragments.
95.60	No pollen; Lycopodium spores, little else
95.20 (bottom)	No pollen; Lycopodium spores, little else
Site 41WM230, Loeve-Fox Site	
sample #540	A few pollen grains, reworked Cretaceous spores and dimoflagellates, large amount of organic debris; numerous Lycopodium spores.

15.5 Phytolith Analysis of Sediments from Archaeological Sites

by

Douglas R. Connor

Introduction

The extraction of biogenic opal, or phytoliths, from the sediments of archaeological sites in the San Gabriel River drainage was undertaken with two objectives in mind. The primary goal was to test the potential of phytoliths as an indicator of past vegetation in the area, while the second was to establish procedures for the extraction, analysis and interpretation of phytoliths from archaeological sites. Because archaeologically applicable analysis of phytoliths is still at a developmental stage, the second task necessarily preceded the first.

The existence of silica bodies as a constituent of the epidermal tissue of plants has been known since the early part of the 19th century (Seuss, 1966). The morphology and distribution of epidermal silica bodies among the grasses has been recognized by plant anatomists as toxonomically significant and possible diagnostic when taken in conjunction with other anatomical characteristics (Metcalfe, 1960). Due, however, to the complexity of the taxonomic endeavor, in which these bodies play only a small part, there has been no large-scale effort to define their significance at a level more exact than that of tribe.

Silica is much more durable than other constituents of plant tissue. For this reason, decomposition of plant material does not destroy these bodies but deposits them in the soil more or less intact. Within the pedogenic process, the silica bodies are known variously as biogenic opal, plant-opal, opal phytolith or, simply, phytoliths. Soil scientists have examined both quantitative and qualitiative aspects of the distribution of phytoliths in both modern soils and paleosols. Beavers and Stephen (1958), Wilding and Drees (1971), Witty and Knox (1964) consider the proportion of phytolith in the soil as an indication of predominant vegetation varying by area or through time. Evidence for the qualitative aspects of distribution is examined in greater detail below. From the archaeologists' perspective, these distinctions often have been too broad to be applied in the context of a specific locality. Moreover, the extraction of pollen from archaeological sediments has long provided not only the satisfying precision of species identification, but has been referable to the vast body of research in Quaternary palynology.

The weakness of phytoliths as a tool for paleoecologeial research results from two factors. First, they are not clearly species-specific as are pollen grains (though in a sense this notion is circular since taxonomic research has not pursued the silica body *in se* as a phylogenetic marker; and, given more tractable alternatives, taxonomists have simply not been forced to advance research toward this end). Second, soil scientists have moved research along several lines simultaneously; phytolith distribution in modern soils, diachronic changes in phytolith spectra, and morphology of phytoliths among the vascular plants (the taxonomic problem). Since these areas are highly correlated, the significance of a given spectrum of phytoliths taken from a given paleosol can only be interpreted in light of the other factors mentioned. To put it succinctly, when large comparative collections of plant opal from many species have been assembled and when phytoliths from modern soil A-horizons have been correlated with existing vegetation, we will be in a much better position to assess the phytoliths from a particular archaeological sediment.

The difficulties in applying phytolith analysis to an archaeological problem are well illustrated by three such studies within the past few years. Rovner (1971) outlined the basic research to date, presented a technique for extraction of phytoliths from sediment and from plant specimens, and illustrated phytoliths from about thirty selected plant species including non-gramineae. The last is especially helpful in that it at least begins to fill in the gaps between the morphology of Twiss, *et al*. (1969) and the germinal work of Wilding and Drees (1973) on opaque types from deciduous trees. Carbone (1977) presented a clear application to archaeological sediments. A column of sixteen samples from the Fifty Site on the Shenandoah River was analyzed in an attempt to detect level changes in vegetation during early Holocene times. Carbone's analysis relied on a spectrum approach, in which phytoliths associated with particular plant families were counted and quantified, then compared from level to level for relative frequency. The spectrum approach has been similarly applied (with limited success) by Peters (1968) in Europe to distinguish chernozem from podzolic paleosols. The work of Pearsall (1978) using phytoliths to distinguish the appearance of domesticated maize (*Zea Mays* L.) in archaeological sediments from Peru represents perhaps the most successful application of phytolith analysis to date. The investigation focused on size variation in the phytoliths of this single species, rather than examining a wide range of plants.

The objective of the current study was to suggest the probable vegetation at several sites in the San Gabriel River drainage and to compare these results with pollen analysis from the same localities. Regrettably, the pollen results were not adequate for comparison. The interpretations advanced below are based upon previous work with phytoliths. They represent, nonetheless, our current state of knowledge in this fledgling science.

Analysis Procedure

Field work for the current project consisted of four days in July and August, 1978, when the sites were visited and plant collections were made with the project botanist, Mr. Ray Kenmotsu. Most of the specimens collected were limited to local grasses and forbs, since the angiosperms had been more systematically collected by Mr. Kenmotsu over the course of the previous six months. Specimens collected were identified by the staff of the Herbarium of Southern Methodist University, Dallas, Texas. These field samples, now pressed and identified may serve as the basis of a systematic type collection of phytoliths for the flora of central Texas. Further time will be required to carry this endeavor to a useful stage, but the work has at least begun.

Sediment samples from three archaeological components were provided by the field director, Mr. Olin McCormick, as follows:

CERVENKA	41WM267	level II	(98.0-97.0)
LOEVE-FOX	41WM230	levels 23-39	(96.52-96.40)
BRYAN FOX	41WM124	level 21	(96.8-96.7)

All three sites were visited and profiles were inspected during the course of field work. The samples were processed, according to the following procedure (Table 15.5-1) in August, 1978. The lab procedures employed follow, with only slight modification, those currently used by Wilding and Drees (MS and personal communication, August 1978).

After mounting, the slides were examined, then photographed through a microscope. The coarse fraction (20-50 microns) was photographed at 100x, the fine fraction (5-20 microns) at 150x. A complete set of prints from these photos is on file for reference at the Institute of Applied Sciences, North Texas State University.

Actual counting was done at 400x magnification since this permitted closer scrutiny and thorough processing of the individual phytoliths. No counting procedures for phytoliths have been standardized. Rovner (1971) counted 100 to 300 particles per modern sample. Carbone (1977) gives no information on absolute frequency while Pearsall (1978) counted 100 particles per sample. Of the latter, her modern species produced 51% of the characteristic cross-shaped phytoliths she used as her marker type. Her archaeological samples, however, produced only 42 examples of 1700 phytoliths counted.

Pearsall's result illustrated one major difficulty in sampling phytoliths from sediment, viz, the absolute frequency of identifiable types may be low compared to amorphous, unidentifiable or what Carbone calls "nondescript" types. Because, however, the relative frequency of identifiable types will generally be employed in examining a phytolith spectrum, the scientist must ensure that he counts a statistically valid total of identifiable types. With these constraints in mind, the following procedure was developed for the San Gabriel samples.

TABLE 15.5-1

EXTRACTION PROCEDURE FOR PHYTOLITHS

1. Place sample in 250 ml beaker and dry on hot plate for c. 3 hrs.

2. Shake sample through 2mm sieve (return coarse fraction to sample bag). Weigh sample.

3. Add to sample 40ml distilled water. Stir. Add ten drops glacial acetic acid (prevents manganese from absorbing H_2O_2 in following step). Stir.

4. Add to sample 40ml Hydrogen Peroxide 27.5% (H_2O_2). When reaction slows, add more H_2O_2 in increments of c. 15ml. Stir occasionally.

5. Let stand until reaction ceases. Place sample on a hot plate and boil slowly to remove excess H_2O_2. Allow sample to cool.

6. Wash sediments from beaker into 1000ml beaker with previously prepared dispersant of 100gm bicarbonate of soda per liter of distilled water. Place beaker on a stirring hotplate and agitate overnight. (Note: A shaking table is preferable for this agitation but none was available during the preparation of these samples. Results obtained here seem to be satisfactory.)

7. Decant sediments into #270 sieve (53 microns) and funnel into large settling container (clean half gallon reagent bottle, for example), with stopper.

8. Using a scale marked on the side of the container, agitate sediments and allow to settle for 5 micron settling time (according to temperature of sample). Discard decantate containing clays. After repeating this decantation five or six times the process can be speeded up by decanting at the 20 micron settling time and reserving the decantate. When the distilled water is clear at the end of the 20 micron settling time, this portion of the sample can be washed into a beaker and dried (by air in a fume hood or slowly over a hot plate).

9. Repeat the settling process for the 5-20 micron fraction, discarding clays in decantate. Dry sample as above. (Note: most of the time required for this extraction process is involved in this isolation of the coarse and fine silt fractions of the sediment.

10. Prepare a heavy liquid flotation medium to isolate phytoliths from silt. Suspend a small steel plummet on a wire; weight plummet in air and again in water. Calculate its weight in a liquid of 2.3 specific gravity. Mix a heavy liquid solution of approximately four parts Tetrabromoethane (TBE) and one part Acetone. Stir. Suspend the plummet in the heavy liquid - adjust specific gravity to 2.3 by adding acetone or TBE as required. NOTE: All mixing and handling of TBE should be done in a fume hood and wearing gloves whenever possible. TBE is volatile and caustic and unhealthy for both human beings and the environment.

11. Measure 2gm of sample into 50ml centrifuge tube and fill 3/4 full with heavy liquid. Centrifuge sample at c. 3000 rpm for five minutes.

12. Prepare a freeze bath of dry ice slush. After centrifuging, mount centrifuge tube in a ring stand so that the bottom inch is immersed in the freeze bath. When the lower portion of the heavy liquid, containing soil particles, is frozen, decant phytoliths through filter paper, reserving heavy liquid. (When the remaining heavy liquid thaws, it should be decanted through a second filter paper, discarding the silts and reserving the heavy liquid as before.)

13. Replacing the container into which the reserved heavy liquid is drained with a separate beaker, wash the sediments in the filter paper several times with acetone to remove residual heavy liquid.

14. After washing, place the filter paper in a beaker and put in drying oven at low temperature overnight.

15. Mount the dried phytoliths in Caedex or other mounting medium on a clean slide.

NOTE: The procedure given above is not suitable for examinations in which the proportion of phytolith in total soil or silt fraction is to be estimated. When such quantification is desired, stricter weighing and washing procedures must be added to the process.

For each fraction at least 250 phytoliths were counted, including unidentifiable as well as identifiable types. This produces a total count per sample of at least 500 particles. Of these, between ten and twenty percent were identifiable types. To reduce the possibility of sampling error, the count of identifiable types only was continued on each slide until at least 100 particles from each fraction had been identified. This produced a total of at least 200 identified types per sample.

This leaves only the question of what constitutes an "identifiable type." The study of Twiss, et al. (1969) is and will probably remain for some time the basic morphological catalog for the gramineae. The basic lists for non-gramineae are those of Geis (1973), Rovner (1971) and Wilding and Drees (1973) on opaque types. Carbone's adaptation of these lists for his study of paleosol spectra would seem at first to offer the most sensible option since the San Gabriel samples present a similar interpretive problem, Carbone's list, however, contains several types not referable to other published studies, e.g., "spearheads" and "corn" (quotation marks his). Since neither type is described or illustrated by Carbone, the San Gabriel samples cannot be described in terms equivalent to Carbone's Fifty Site. There is, moreover, no reason in the opinion of this writer, to divide the quantification of a phytolith sample into two fractions. This division is for convenience during silt fractionation and has no relevance to the phytolith spectrum iteslf.

It is clear that some types such as crosses and dumbbells are nearly always limited to the 5-20 micron fraction while others such as keystones usually occur in the 20-50 micron fraction. Many distinctive types, however, such as rectangles, circles and ellipses occur in both fractions. Carbone (1977:194) further cites Yeck's 1969 dissertation (non vidi) to the effect that overall size characteristics may be affected by regional moisture gradient. Size is not without importance in dealing with phytoliths. Geis (1973) notes that more than 93% of phytoliths from angiosperm forest floors were smaller than 20 microns. Wilding and Drees (1971) corroborate that in this size range phytoliths from deciduous trees have their most distinctive morphology while in the coarse fraction the distinctions between grassland and forest opal are likely to appear most clearly. None of these considerations, however, suggest that, except for convenience, the phytolith sample itself should be quantified or analyzed by fraction. In the analysis which follows, the results of counts on both coarse and fine fractions have been combined.

The type list employed (Table 15.5-2) is that of Twiss, et al. (1960) combined with the non-gramineae types of Rovner (1971) and the "keystone" of Carbone (identified as a common grass type by Wilding and Drees (1971), inter alia). One other type was added to these forms, a clear cubic phytolith which occurred relatively frequently in the samples. This was grouped for quantification with the rectangle of Twiss, et al. After the counts were completed, it was determined that

TABLE 15.5-2

PHYTOLITHS: IDENTIFIABLE TYPES AND CATEGORIES*

(Key: Figure in parentheses refers to the type number as published by previous researcher, e.g., 2a-T, refers to Twiss, *et al.*, Type 2a; the letter R=Rovner, C=Carbone)

Grass Types

Short Grass Types

1. Circular (1a-T)
2. Elliptical (1c-T)
3. Rectangular and Cubic (1b-T)
4. Oblong (1g-T)
5. Chloridod (2a-T)

Long Grass Types

6. Crosses (3a,b-T)
7. Dumbbells (3c-j-T)
8. Biconcave Rectangles (2j-R)

Common Grass Types

9. Rods - all varieties (41-e-T)
10. Caps (2g-R)
11. Trichomes (2f-R)
12. Keystones (2 large fraction - C)

Non-Grass Types

Deciduous

13. Stomata (1a-R)
14. Hair Cells (1d-R)
15. Cellular Aggregates (1e-R)

Conifers

16. Square Net-like

Herbs

17. Globules (1i,j-R)
18. Ringed and Paired Rods (1n,o-R)

Other Types

19. Other

Opaques

Nondescript, translucent

Nondescript, clear

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*This list represents a recompilation of results of the counts from the San Gabriel samples. During the counting process, all crosses, dumbbells and rods were typed according to the more precise morphology presented by Twiss, *et al.* (1960). Only for purpose of quantification were they lumped together as in the current list. The original data are on file at the Institute of Applied Sciences, North Texas State University.

the following types were sufficient to describe all but a small proportion (±.5%) of the morphologically identifiable shapes.

Interpretation

The results of the counting procedures outlined above are presented in Tables 15.5-3 to 5. Figures 15.5-1,2 presents these results graphically. The histogram shows the relative proportion of types where total counts were made on the sample; the cumulative graph shows the relative frequency of identifiable types. Acknowledging all the difficulties presented above, a few cautious remarks about the implication of the results for the paleoecology of the San Gabriel River drainage are in order.

First, there appear to be more grass types than non-grass types in both total and type counts. Combining opaques, presumably of forest origin, with non-grass types the predominance of grass types is roughly 3:1 at Cervenka and Loeve-Fox, but is only about 1:1 at Bryan Fox. A potentially confusing element here is the proportion of translucent particles. Wilding has identified similar amorphous globular conglomerates in Illinois soils as being of forest origin (personal communication). If one includes these with the non-grass types the ratios of grass to other types are roughly: Cervenka 1:2.5; Loeve-Fox, 1:1; Bryan Fox 1:6. What is informative about both sets of comparisons is the suggestion that grasses figured more prominently in the vegetation at Loeve-Fox and less prominently in the vegetation at Bryan Fox, with Cervenka somewhere inbetween. The second comparison, however, raises the question of how much of the clear non-descript portion should be ascribed to grasses. Here we may simply note that the proportion of clear-nondescripts to translucents at each site is consonant in rank with the proportion of identifiable grass and non-grass types.

The type counts (Tables 15.5-3 to 5) suggest a clear dominance of short grass (panicoid) over long grass (poacoid) types. Herein may be the most reliable result of the present study. In fact, a short grass dominance would be consistent with the native vegetation as defined for this area by Tharp (1952). The predominance of grassland over woodland types may suggest that woodland vegetation was limited to the land fringing the drainage channels, while the major portion of the area was open, short grass prairie.

It is tempting to push the conclusions further. Reduced to relative frequencies, the results assume a tempting air of scientific accuracy. At the present stage of understanding, to yield to such a temptation would be more misleading than enlightening. Nevertheless, the results to date suggest that phytolith studies may prove of increasing value in assessing paleoecology as refinement in our understanding can be effected.

TABLE 15.5-3

CERVENKA SITE (41WM267) PHYTOLITHS

	Total Count (n=557)		Type Count (n=261)	
	Absolute	Relative	Absolute	Relative
Grass Types:		10.78		85.45
Short Grass types		4.31		37.55
1. Circular	3	0.54	6	2.30
2. Elliptical	1	0.18	15	5.75
3. Rectang/Cubic	17	3.05	67	25.67
4. Oblong	1	0.18	5	1.92
5. Chloridoid	2	0.36	5	1.92
Long Grass types		0.36		4.99
6. Crosses	1	0.18	5	1.92
7. Dumbbells	1	0.18	6	2.30
8. Biconcaves	0	0.00	2	0.77
Common Grass types		6.11		42.91
9. Rods	23	4.13	78	29.89
10. Caps	0	0.00	1	0.38
11. Trichomes	3	0.54	6	2.30
12. Keystones	8	1.44	27	10.34
Non-Grass Types:		0.54		8.82
Deciduous		0.36		6.52
13. Stomata	1	0.18	8	3.07
14. Hair Cells	0	0.00	1	0.38
15. Cell. Aggreg.	1	0.18	8	3.07
Conifers		0.18		0.77
16. Sq. Netlike	1	0.18	2	0.77
Herbs		0.00		1.53
17. Globules	0	0.00	0	0.00
18. Rngd/Prd Rods	0	0.00	4	1.53
Other Types:				
19. Other	2	0.36	15	5.75
Opaques	24	4.31		
Nondescript, transluc.	128	22.98		
Nondescript, clear	338	60.68		

TABLE 15.5-4

LOEVE-FOX SITE (41WM230) PHYTOLITHS

	Total Count (n=604)		Type Count (n=280)	
	Absolute	Relative	Absolute	Relative
Grass Types:		18.71		90.73
Short Grass types		10.27		45.00
1. Circular	3	0.50	7	2.50
2. Elliptical	3	0.50	7	2.50
3. Rectang/Cubic	33	5.46	58	20.71
4. Oblong	18	2.98	26	9.29
5. Chloridoid	5	0.83	28	10.00
Long Grass types		1.00		7.86
6. Crosses	0	0.00	4	1.43
7. Dumbbells	3	0.50	11	3.93
8. Biconcaves	3	0.50	7	2.50
Common Grass types		7.46		37.87
9. Rods	28	4.64	82	29.29
10. Caps	3	0.50	4	1.43
11. Trichomes	0	0.00	1	0.36
12. Keystones	14	2.32	19	6.79
Non-Grass Types:		0.67		3.22
Deciduous		0.67		2.50
13. Stomata	0	0.00	1	0.36
14. Hair Cells	1	0.17	3	1.07
15. Cell. Aggreg.	3	0.50	3	1.07
Conifers		0.00		0.36
16. Sq. Netlike	0	0.00	1	0.36
Herbs		0.00		0.36
17. Globules	0	0.00	0	0.00
18. Rngd/Prd Rods	0	0.00	1	0.36
Other Types				
19. Other	6	0.99	17	6.07
Opaques	31	5.13		
Nondescript, transluc.	90	14.90		
Nondescript, clear	360	59.60		

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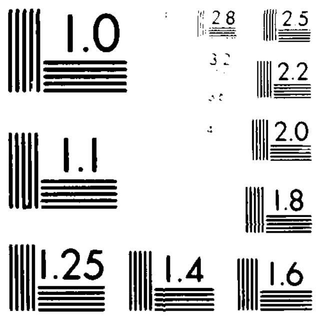
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TABLE 15.5-5

BRYAN FOX SITE (41WM124) PHYTOLITHS

	Total Count (n=604)		Type Count (n=280)	
	Absolute	Relative	Absolute	Relative
Grass Types:		4.66		77.83
Short Grass types		3.09		39.13
1. Circular	0	0.00	3	1.30
2. Elliptical	6	1.03	17	7.39
3. Rectang/Cubic	10	1.72	58	25.22
4. Oblong	1	0.17	9	3.91
5. Chloridoid	1	0.17	3	1.30
Long Grass types		0.34		11.30
6. Crosses	0	0.00	10	4.35
7. Dumbbells	2	0.34	10	4.35
8. Biconcaves	0	0.00	6	2.61
Common Grass types		1.20		27.40
9. Rods	5	0.86	49	21.30
10. Caps	0	0.00	1	0.43
11. Trichomes	1	0.17	1	0.43
12. Keystones	1	0.17	12	5.22
Non-Grass Types:		2.59		17.40
Deciduous		1.55		11.31
13. Stomata	5	0.86	10	4.35
14. Hair Cells	1	0.17	2	0.87
15. Cell. Aggreg.	3	0.52	14	6.09
Conifers		0.00		0.00
16. Sq. Netlike	0	0.00	0	0.00
Herbs		1.03		6.09
17. Globules	6	1.03	14	6.09
18. Rngd/Prd Rods	0	0.00	0	0.00
Other Types:				
19. Other	2	0.34	11	4.78
Opaques	8	1.38		
Nondescript, transluc.	150	25.86		
Nondescript, clear	378	65.17		

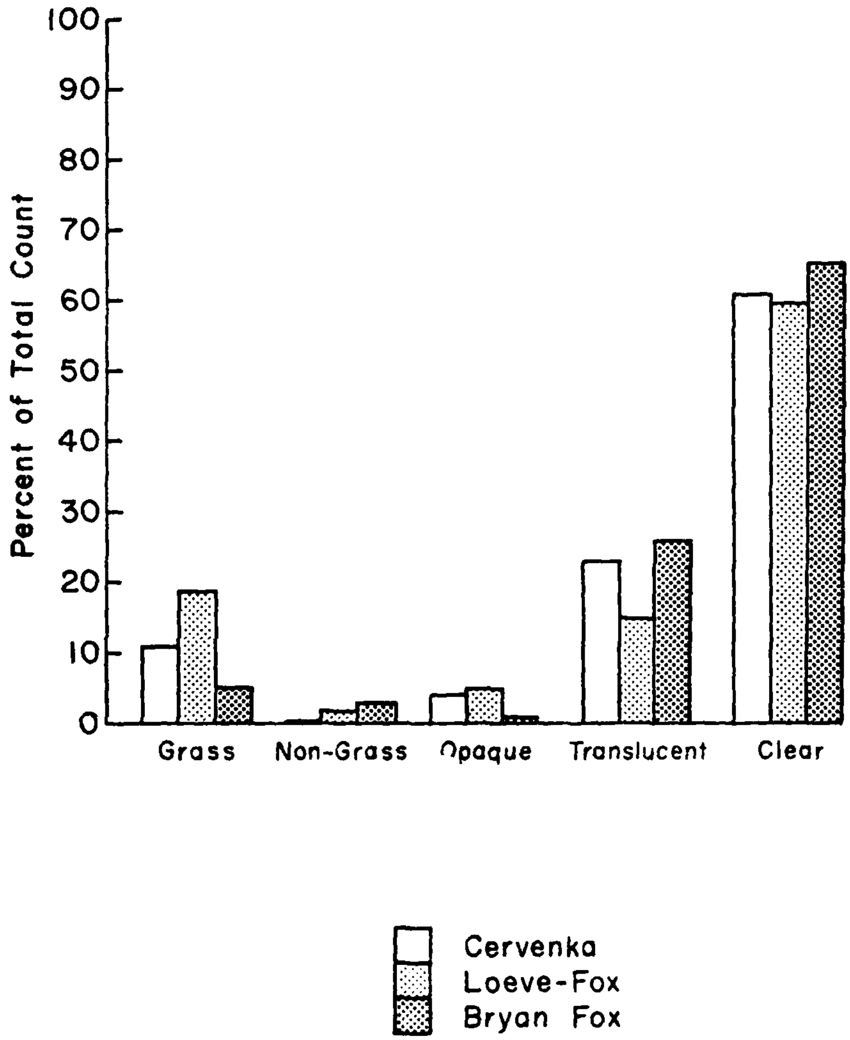

Figure 15.5-1. Phytolith Proportions

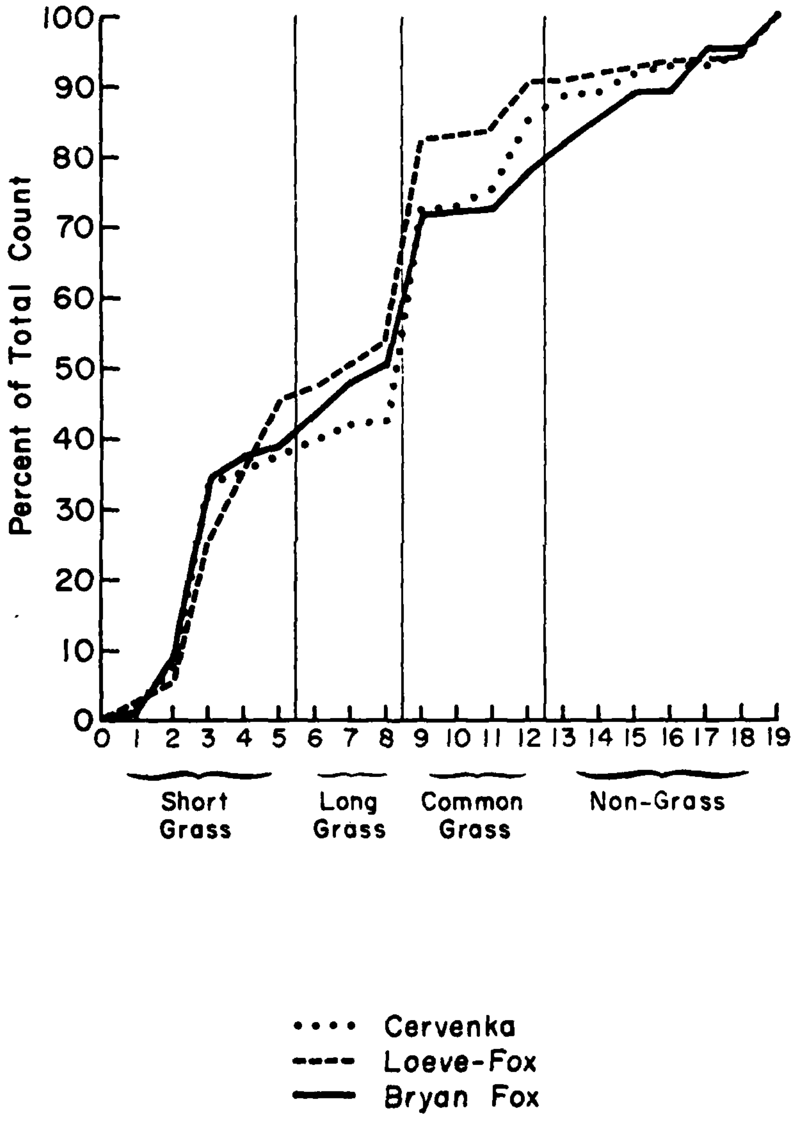

Figure 15.5-2. Phytolith Relative Frequencies

15.6 Invertebrate Faunal Analysis

by

Richard and Kate Fullington

Mollusca Literature Review: San Gabriel River Drainage

Bivalvia

Strecker (1931) listed 30 bivalve species and subspecies for the entire Brazos River system including the Little River, which in turn drains the San Gabriel River. All North Fork and Granger Reservoir sites identified species are listed by Strecker with the exception of *Cyclonaias tuberculata* (Rafinesque) and *Lampsilis radiata siliquoidea* (Barnes). Thus, these two species are new county records for Williamson County. They would also be new State records except that, apparently, Burch (1975) includes most of Texas in his "Entire Mississippi River Valley System" distributional description and Simpson (1914) lists *C. tuberculata* for "Texas". *L. r. siliquoidea* in also for Texas by Simpson (1914) and Clarke and Berg (1959).

Gastropoda

Table 15.6-1 summarizes the gastropod literature review for Williamson County (North Fork and Granger Reservoirs) taken from the most recent comprehensive literature source on Texas Mollusca (Cheatum and Fullington, 1971, 1973; Fullington and Pratt, 1974). Table 15.6-2 lists the molluscan fauna recovered from archaeological sites in the North Fork and Granger Reservoirs.

Ecology of Recovered Molluscan Fauna

Gastropoda: Terrestrial

Helicina orbiculata tropica. (only operculated, gill-breathing land snail in North America). A calciphile, occurring in localized colonies, usually in deciduous or juniper woodlands and absent from grassland habitats although often found in riparian woodland corridors along prairie streams. Semi-arboreal, it will aestivate in the open on rocks and trees during dry, summer periods and in the winter, hibernates in soil at the base of trees and rocks.

Table 15.6-1

Gastropod Occurrence in Williamson County

Gastropod	At Sites	Literature
Helicina orbiculata tropica	X	X
Praticolella berlanderiana	X	X
Praticolella griesola		X
Gastrocopta procera procera		X
Gastrocopta contracta		X
Vallonia pulchella		X
Strobilops texasiana	X	X
Rabdotus dealbatus dealbatus	X	X
Rabdotus mooreana		X
Euglandina singleyana	X	
Hawaiia miniscula		X
Mesodon thyroidus	X	
Polygyra auriformis	X	
Pupoides albilabris	X	
Rumina decollata	X	
Misomphix friabilis	X	
Anguispira strongylodes	X	
Polygyra texasiana	X	X
Polygyra mooreana	X	X
Helicodiscus parallelus	X	
Physa virgata	X	
Helisoma tribolvis lenta	X	
Gynaulus parvus	X	
Lymnaea humilus	X	
Biomphalaria obstructa	X	

Table 15.6-2

RECOVERED MOLLUSCAN FAUNA

North Fork Reservoir and Granger Reservoir Sites

Gastropoda

Terrestrial

Family Helicinidae
Helicina orbiculata tropica (Pfeiffer)

Family Bulimulidae
Rabdotus dealbatus dealbatus (Say)

Family Polygyridae
Polygyra texasiana texasiana (Moricand)
Polygyra mooreana (Binney)
Polygyra auriformis (Bland)
Praticolella berlanderiana (Moricand)
Mesodon roemeri (Pfeiffer)
Mesodon thyroidus (Say)

Family Endodontidae
Anguispira strongylodes (Pfeiffer)

Family Zonitidae
Mesomphix friabilis (Binney)
Zonitoides arboreus (Say)
Glyphyalinia indentata paucilirata (Pilsbry)

Family Pupillidae
Pupoides albilabris (Adams)

Family Achatinidae
Rumina decollata (Linnaeus)

Family Spiraxidae
Euglandina singleyana (Binney)

Family Succineidae
Succinea sp.

Family Endodontidae
Helicodiscus parallelus (Say)

Gastropoda (continued)

Family Strobilopsidae
Strobilops texasiana (pilsbry and Ferriss)

Aquatic

Family Physidae
Physa virgata (Gould)

Family Planorbidae
Biomphalaria obstructa (Morlet)
Helisoma trivolvis lenta (Say)
Gyraulus parvus (Say)

Family Lymnaeidae
Lymnaea humilus (Lea)

Bivalvia

Family Unionidae
Amblema plicata (Say)
Carunculina parva (Barnes)
Lampsilis radiata siliquoidea (Barnes)
Lampsilis teres (Rafinesque)
Megalonaias gigantea (Barnes)
Tritogonia verrucosa (Say)
Unionmerus tetralasmus (Say)
Cyrtonaias tampicoensis (Lea)
Cyclonaias tuburculata (Rafineque)
Quadrula quadrula (Rafinesque)
Liqumia nasuta (Say)

Family Sphaeriidae
Pisidium casertanum (Poli)

Family Corbiculidae
Corbicula manilensis (Philippi)

Miscellaneous

Cretaceous oyster

Rabdotus dealbatus dealbatus. Occuring in disjunct colonies, it is usually found along stream bottoms and open woodlands within open grasslands. In Texas, it is a typical terrace deposit inhabitant. Principally a night feeder, and during wet, overcast days, it is found under rocks in the day and burrows several inches into the soil prior to winter hibernation.

Polygyra texasiana texasiana. This species is found under rocks or logs in deep woodlands or open prairies. It is usually a major component of drift material along streams. Apparently it is not a burrower, otherwise very little is known of its ecology.

Polygyra mooreana. The habitat preference of this species is quite similar to that of P. t. texasiana and usually are sympatric. It is also found under rocks and organic debris, particularly on sparsely wooded hillsides.

Praticolella berlanderiana. Like all polygyrids, the genus apparently originated in Mexico and this species, in particular, prefers a cooler, moderately dry to semi-arid climate. It will burrow for hibernation or during drought under rocks and other organic debris.

Polygyra auriformis. Occuring only from Florida to Texas, the ecology of this species is relatively unknown. In Texas, it is usually found in small colonies along deep riparian woodlands bordered by limestone bluffs. Apparently very moisture dependent, it lives under deep organic debris and rocks.

Mesodon throidus. This species, like M. roemeri, is usually found in woodlands associated with rotting logs and humus. It has been found along with M. roemeri feeding upon moist bracket fungi and "toadstools".

Mesodon roemeri. Although it is most commonly found in wet, dense riparian woodlands, colonies may occasionaly occur on sparcely-wooded calcareous slopes. It appears to particularly prefer living under organic debris such as logs and wet leaf litter. Colonies occur in disjunct populations even along one continuous stretch of stream woods.

Anguispira strongylodes. A colonial species, it generally is found under deciduous logs in moist, shaded areas especially on river floodplains. The eastern edge of the Balcones Escarpment is the limit of its range to the west. It is never found in open areas and is often absent in seemingly suitable habitats. Within a colony, it is most often very numerous.

Mesomphix friabilis. This species also occurs under deciduous logs and organic debris on river floodplains in widely scattered abundant colonies. Its western range limit is also to the edge of the Balcones Escarpment and its distribution in Texas appears to be retreating eastward and is absent along most of the Gulf Coastal Plain.

Zonitoides arboreus. A widely distributed species from southern Canada to Central America, but absent on the Great Plains, it occurs under fallen logs and other organic litter in moist wooded areas. Its current distribution in Texas also appears to be retreating eastward when compared to fossil distribution records. Otherwise, its ecology is little known.

Glyphalinea indentata paucilirata. Recent studies of this species indicate that it may better be referred to as G. umbilicata (Pratt and Fullington, in press) but the distinction can be made only through anatomical comparisons and the use of G. i. indentata is entirely legitimate for the purposes of this report. It occurs under rocks, logs and leaf litter in deciduous and evergreen woodlands, primarily on limestone or calcereus sands. Like most of the thin-lipped, small zonitids, it has an annual life cycle.

Pupoides albilabris. Widely distributed in Eastern Northern America, it is most abundant in limestone areas occuring under rocks, in grass roots and leaf litter in sparse woodlands. Its apparent non-specific habitat requirements makes this species an unreliable indicator of past climatic conditions.

Rumina decollata. The time of this Mediterranean species' introduction to the New World is unknown, but it is now widely distributed in North America. Its sparse occurrence in some of the site areas is totally unexplainable at this time.

Euglandina singleyana. According to Fullington and Pratt (1974), near the eastern edge (Balcones Escarpment) of its range (Central Texas), it occurs under rocks and logs along wooded limestone-bluffed streams. East of the Escarpment it occurs infrequently in wooded sand or clay bottomed lowlands. This species is carniverous and does not live in large colonies.

Succinea sp. This genus is quite indicative of a drier climate occurring in open woodlands surrounded by prairies under rocks. Since the species cannot be identified, exact habitat preferences cannot be utilized for the purposes of this investigation.

Helicodicus parallelus. According to Pilsbry (1948), this forest snail "... lives on decaying wood in shady or humid places, also on damp leaves". This species is a typical inhabitant of heavily wooded flood plains.

Strobilops texasiana. Around rotten logs, especially under loose bark, and in leaf litter; sometimes collected in net sweepings from grass in woodland areas.

Gastropoda: Aquatic

Physa virgata. This very adaptable and genetically plastic species occurs in firtually all types of lentic and lotic waters and is obviously useless as an indicator of past environmental conditions.

Helisoma trivolvis lenta. This pulmonate also thrives in almost any type of aquatic habitat with the exception that the water must be permanent. In Texas, it usually found with P. virgata.

Gyraulus parvus. A common North American species, G. parvus generally occurs in the quite backwater areas of streams and ponds with abundant aquatic vegetation. In Central Texas, it was found to be most common in slow flowing streams choked with submergent vegetation (Ceratophyllum or algal mats).

Lymnaea humilus. This species most commonly occurs in shallow, algae-filled and muddy bottomed backwater area of lakes and streams. It also can be found crawling on exposed organic ooze near the water.

Biomphalaria obstructa. This species is a South American pulmonate that inhabits a wide variety of aquatic habitats. In Texas, it has been found in clear flowing streams, lakes and temporary ponds. Living specimens have been collected from mud in a dry stock tank in Brewster County. Due to its non-habitat specificity, any conclusions drawn of past environmental conditions are limited.

Bivalvia

Amblema plicata. (Three-Ridged Mussel). This widely spread species in North America inhabits streams, lakes and large ponds which is slightly unusual as most freshwater clams are relatively habitat specific. Its general greater abundance in Texas archaeological sites than the other equally accessible sympatric stream species (Lampsilis spp., Quadrula, Proptera, etc.)indicates an unknown human selection factor such as palatibality or more biomass obtained with less energy expenditure (gathering).

Lampsilis radiata siliquoidea. (Fat Muckel Mussel). Although Baker (1928) described this species' habitat preference as quiet water with mud bottoms, Murray and Leonard (1962) found it occuring in almost any type of stream substrates except shifting sands. In Texas, at least, it primarily occurs in streams rather than in lentic waters (personal observations).

Lampsilis teres. (Yellow Sand-Shell Mussel). Most commonly referred to in literature as L. anodontoides, this species also occurs in large and small streams; slow and fast moving water; rocky and muddy bottoms; and in shallow or deep water.

Cyrtonaias tampicoensis. All that is known of this indigenous Central and South Texas species is that it appare.,tly is a stream and river form with a preference for rocky or gravelly bototm.

Quadrula quadrula. (Maple-Leaf Mussel). This principally stream dweller with no apparent substrate preference is often found inTexas man made impoundments which indicates that it can adapt to lentic waters as long as the water is clear and well-oxygenated. In streams, it occurs in shallow and deep water. Its extremely thick shell and relatively small biomass would appear to make it an undesirable food source although easily collected.

Megalonaias gigantea. (Giant Washboard Mussel). This largest of all the North American freshwater clams typically occurs in muddy bottoms of streams and rivers where the water is deepest (usually ten feet or deeper). Despite the very large biomass per individual, the rare occurrence of M. gigantea in Texas archaeological sites is probably due to its preference for deep water.

Carunculina parva. (Lilliput Mussel). This species is found most often in small streams having sluggish current and muddy bottoms. It frequently occurs near the banks of large streams in water no more than 2 to 3 inches deep.

Tritigonia verrucosa. (Buckhorn Mussel). This mussel is found in almost every stream habitat except bottoms of shifting sand. It occurs in rocky, silty, hard mud and soft mud bottoms, and is common to both large and small streams.

Uniomerus tetralasmus. (Pond-Horn Mussel). The Pond-Horn is most frequently found in ponds, lakes, and small quiet streams in habitats of soft or hard mud bottoms in shallow water. Occasionally, the species occurs in larger streams having quiet, pondlike areas.

Cyclonaias tuburculata. The most favorable conditions for this species are to be found where there is coarse gravel and boulder bottom. It is much scarcer in lower sections of the river on sand and gravel where the current is less rapid.

Ligumia subrostrata. (Common Pond-Mussel). It occurs abundantly in ponds and creeks in soft to hard mud. It is rarely found in rocky bottoms. In the larger streams it may be abundant locally, but always in shallow pondlike areas of the river.

Pisidium casertanum. This species has succeeded in adapting itself to a wide variety of habitats. It has been collected in bog ponds, ponds, swamps that dry up for several months of the year, swamp-creeks, creeks with considerable current, rivers, and lakes. Usually found in mud bottom deposits among lotic areas of variable current speed.

Corbicula manilensis. This species, introduced from Asia, has quickly adapted to a variety of lotic and lentic habitats throughout the entire North American continent.

North Fork Reservoir Mollusca

Site 41WM53

Area A

In comparison, Unit 98N/130W (fine-screen) yielded only two more gastropod species than did Unit 99N/130W (no fine-screen) although it did yield, on the average, more individuals per species. Three species (H. o. tropica, R. d. dealbatus, P. berlanderiana) when compared density/level showed an overall population expansion from Level 1 to Level 6 and a contraction from Level 6 to Level 9 (Appendix D).

Although Rabdotus d. dealbatus, numerically, was the overall dominant species in both units, it is interesting to note that its numbers decreased upward through each level whereas the second most dominant species, H. o. tropica increased. This phenomenon cannot be explained as both are relatively drier climate species. However, H. o. tropica appears to require a more woody habitat.

The presence of these two species and the dry climate species, P. berlanderiana climatically indicates that Area A remained relatively dry through all levels (1-8). However, a more moist period must have occured through levels 4 and 5 as the numbers of species and individuals were both higher than through levels above and below 4 and 5.

Areas B, C

As molluscan material (one level each) of Areas B and C yielded one adult valve/Area of Lampsilis radiata siliquoidea, no meaningful interpretive statements can be made concerning these two Areas.

Conclusion

Analysis of the molluscan fauna recovered from Site 41WM53 indicates that the area was not frequently flooded through Levels 1-9 as no aquatic gastropod species and only three bivalve species (10 specimens) were present.

Initial observation of the molluscan data from Area A invoked an intriguing possibility that man, even at an earlier time period than present, made heavier impact on the environment than would be supposed. Very mesic, dense understory cover requiring species such as Anguispira strongylodes and Mesomphira occur in the lower Levels

but not in the upper levels, indicating a decline in the lushness of woodland understory vegetation. The question posed was whether or not this change in the amount of undercover vegetation was brought about by man clearing for more living space or from climate change. A definitive statement concerning the possibility of having clear evidence of early human impact is simply not possible upon closer examination of the molluscan data from Area A.

The low numbers of bivalve species and individuals recovered indicate that either mussels were not used as a significant food source or that the site was utilized for some type of activity that did not necessitate long term habitation.

The occurrence of the imported land snail Rumina decollata in Levels 2 and 5 cannot be explained. The three specimens were immature. Most probably the specimens entered the matrix bags during some stage of bag storage. The examined shells were all fresh and shiny.

Site 41WM56

Area A

Examination of the molluscan specimens recovered from the provided 12 Units revealed only meager information. However, significant data is worth discussion. Fire-charred unionid fragments were found at Unit 1026N/1093W (Level 3)--Lampsilis teres and at Unit 1027N/1093W (Level 7)--Amblema plicata. Although only a comparatively few unionid species and individuals occurred at each level in all Units, A. plicata was the dominant species in all levels (Appendix D).

Levels 4-5 appeared to be the most active levels in all Units from the standpoint of containing the most number of species and individual specimens. A single, adult specimen of the carniverous land snail, Euglandina singleyana was recovered from Unit 1026N/1094W (Level 5) which indicates that, at least at that Level, the area was heavily wooded and quite moist. These climatic and environmental conditions are a prerequisite for this species in this particular section of its range.

Area B

The molluscan data obtained showed to be very similar in character to Area A. Relatively few bivalve species and individuals occurred at each level of all the examined Units. Fire-charred specimens of A. plicata were observed at Units 1041N/1105W (Level 6) and 1042N/1105W (Level 6). A single specimen of E. singleyana was found at 1041N/1106W (Level 6) and the smallest North American unionid, Carunculina parva, was also obtained from Units 1041N/1106W (Level 6) and 1042N/1106W (Level 5). The occurrence of this tiny species (maximum length--30mm) suggests that some flood deposition took place at these levels.

As at Area A, Amblema plicata was the dominant species at all Units and Levels. Abnormal valve cleavage angles of this species also indicated human usage. Although uncharred, the unbo shape of the other Area B unionids (Lampsilis radiata siliquoidea, L. teres) also suggests human usage of these species. Levels 5 and 6 in terms of species and individual numbers plus obvious human activity were the most active levels in all Units in Area B.

Area C

Analysis of the gastropods and bivalves recovered from Unit 1063N/1098W (Levels 1-12) confirmed the probability that much of the molluscan fauna for the entire site was mostly flood-deposited as suggested by the bivalve data obtained from Areas A-F. Irregardless, Area C yielded some very unique information when the 25 examined Units were treated as a whole (Appendix D).

Of the 25 fire-charred specimens recovered from Area C (all levels), 12 were gastropods (11 R.d. dealbatus, 1 P. t. texasiana). These specimens were found in Levels 1-9 and 12. None of the Rabdotus shells exhibited any evidence of human usage and the small (10mm. diameter) P. t. texasiana would obviously be undesirable as a food source. The majority of the specimens were in Level 4. This gastropod data provides evidence that Indian activity was fairly continuous through all levels and that fires (cooking?) were built in the same places for long periods of time. Whether or not the site was continually or periodically inhabited cannot be accurately determined from the available molluscan data. However, there must have been periods of inactivity that allowed the snails to either migrate into the fire sites or be flood-deposited. Table 15.6-3 lists the mollusks arranged by level sequence.

Several other observations on Area C are worth mentioning. One adult valve of L. r. siliquoidea (1061N/1100W--Level 5) contained two strangely shaped, rectangular "unnatural" holes. How and why these holes were made in the valve is unexplainable at the present.

The consistent numbers of more arid or open-hillside dwelling gastropod species in all levels of Unit 1063N/1098W suggests that the entire site may have been flooded more frequently by either the intermittent streams cutting through the limestone bluff between Site 41WM56 and Site 41WM57 rather than the river itself, or these species may have been brought in by runoff from the adjacent steep bluff. Only a relatively few of the more riparian woodland snails such as A. strongylodes were recovered and no M. friabilis at all. It is also interesting to note that in Level 4 of the above Unit only H. o. tropica was found. Perhaps the Indians decided to clean out midden debris.

Table 15.6-3

Mollusks from Site 41WM56

Level	Unit	Mollusk
1	1062N/1100W	*A. plicata*
3	1061N/1077W	*R. d. dealbatus*
	1062N/1100W	*R. d. dealbatus*
	1063N/1097W	*L. r. siliquoidea*
	1063N/1098W	*A. plicata*
4	1060N/1098W	*A. plicata*
	1062N/1097W	*R. d. dealbatus*
	1063N/1098W	*L. teres*
5	1060N/1100W	Unid. unionid frag.
	1061N/1098W	*P. t. texasiana*
	1062N/1098W	Unid. unionid frag.
	1063N/1100W	*R. d. dealbatus*
6	1061N/1098W	*A. plicata*
	1062N/1100W	*R. d. dealbatus*
7	1063N/1097W	*C. tampicoensis*, 2 unid. unionid frag.
	1064N/1099W	*R. d. dealbatus*
8	1060N/1097W	*R. d. dealbatus* (2)
9	1061N/1100W	*R. d. dealbatus*
10	1063N/1097W	*L. teres*
	1064N/1099W	*R. d. dealbatus*
12	1060N/1098W	Unid. unionid frag.
	1062N/1097W	*R. d. dealbatus*

Areas D, E, F

Little significant molluscan data was obtained from these Areas. Fire-charred specimens of A. plicata and an unidentifiable unionid fragment were found in Area D (1049N/1111W--L. 12, 1049N/1112W--L. 2, 1050N/1112W--L. 9). At Area E, fire-charred valves of A. plicata and L. r. siliquoidea were found in Unit 1046N/1092W--L. 9. No fire-charred specimens were observed at Area F. Amblema plicata was the dominant bivalve at each Area and no levels showed unusual activity. • Interestingly, the closest Area to the San Gabriel River (Area F) contained the fewest number of recovered mollusks (collecting bias?).

Site 41WM57

Examination of the molluscan fauna recovered from Site 41WM 57 provided a surprisingly insignificant amount of data. This is surprisingly from the fact that the adjacent site, 41WM56 yielded much useful information.

No fire-charred specimens were observed from this site whereas many gastropod and bivalve specimens were charred in Site 41WM56. Observation on the snail column recovered from Area C (Unit 1027N/1019W, Levels 2-5) through a lens of burned rock showed a tremendous individual numbers explosion of three species (H. o. tropica, r. d. dealbatus, P. mooreana) with an equally rapid decrease. If this particular area could be re-investigated, a very significant archaeological/molluscan relationship most probably could be established. It should be noted that the snail species found in this particular column are more dryland species (off the bluff as with Site 41WM56) and no aquatic species occurred in the column. The bivalve data from this site reinforced the supposition made from the bivalve data from all of the North Fork Reservoir sites that mussels were not a significant food source. As in the other sites, A. plicata was the dominant mussel in all the areas at Site 41WM57.

Site 41WM73

Areas A, C

Only two bivalve species [A. plicata (4), L. r. siliquoidea (4)] were recovered from these Areas. No specimens showed evidence of human usage (fire-charred, etc.) and no meaningful interpretation could be derived from this material.

Area B

Although 4,485 molluscan specimens (17 species) were recovered and examined from 22 levels at Area B; unfortunately, only a small amount of

positive data could be gleaned for several reasons. However, a discussion of the "negative" data for this Area will demonstrate that excavation time spent here (at least from the molluscan viewpoint) was well worthwhile. In fact, Area B of Site 41WM73 can be used as a standard for almost all the other examined sites.

Upon examination of the gastropod species, almost every level included a mixture of aquatic snails (P. virgata, H. t. lenta, G. parvus) dry upland snails (P. berlanderiana, Succinea sp., P. albilabris) and high-moisture requiring low woodland snails (H. parallelus, M. roemeri, Z. arboreus) clearly indicating that the specimens were flood-deposited. The total number of specimens also drastically rises in the regions where the above admixture occurs

Most importantly, an examination of the adaphic and limnological structure surrounding this site from a topographic map shows that the entire site sits in a catch-basin. High water coming from upstream eddys in the depression carved from the surrounding bluffs and drift material tends to collect and remain after the water level drops.

On the positive side, excavation intensity can be kept at a minimum on future sites located in such locals. Also, this site yielded the fire-charred organic remains of a snail (Rabdotus?) which should become an invaluable comparative tool. Organ parts can still be determined under a microscope. Site 41WM267 in the Granger Reservoir area contains a snail column that represents a clear contrast for "in situ" deposition.

Site 41WM304

In general, Site 41WM304 contained a molluscan fauna quite similar to the recovered molluscan faunas in the entire North Fork Reservoir Area. The snail column from Area B showed that most of the mollusks in each were primarily flood-deposited. However, as in the case of the other examined sites, the numbers of species and individuals decreased toward the surface. This suggests a general drying trend of the whole region combined, most likely, with human impact.

Only one fire-charred valve of Amblema plicata was recovered at the site (Area A, Unit 108N99W--Level 16). A. plicata was the dominant mussel in all levels of both Area A and Area B. In fact, above Level 8 in each Area, A. plicata was the only mussel present. In Units 107N/99W, 108N/100W, 118N/99W, 118N/100W, 119N/99W and 119N/100W, it was the only mussel present. It has been postulated several times in this report that apparently the mussel fauna of the North Fork of the San Gabriel River did not serve as a significant food source. The river in this area (and its tributaries), judging from the number of species recovered at all sites, supported a rather depauperate bivalve fauna. In support of this supposition, it was noticed that in most sites a variety of aquatic snail species were present indicating flood-deposition. In

these same sites the bivalve fauna remained consistent in species composition and the floods surely would have added more species if more species had been in existence in the River.

A series of Rabdotus d. dealbatus shells from Area B, Level 6 exhibit a series of holes on the body whorl that are clearly teeth impressions of an animal. The spacing and circular nature of the holes indicate that they were made by canine teeth which rules out rodents. Many midden shell specimens have these holes (some are obviously bird beak holes) and several unanswered questions arise from this knowledge. What mammal in Central Texas would be of the size indicated by the diastema between the holes and what animal would use the middens as a refuge? Did this animal carry the shells in or simply feed on the snails that came into the midden area of their own volition attracted by organic debris? These thoughts should be remembered when any midden gastropod material is numerically analyzed. For example, most of the midden material examined during this project contained very large numbers of gastropods. Do the snails accumulate in middens by attraction to decaying organic debris left by the Indians or are they mostly carried in by animal activity.

In conclusion, the land snail fauna recovered from Area B is composed almost exclusively of drier habitat species and deep woodland species (A. strongylodes, M. friabilis, Mesodon) are completely absent. Thus, most probably Site 41WM304 was sparsely wooded and comparatively dry in climate during the period of time covered by the level sequence.

Site 41WM328

Area A

Only two bivalve species were recovered from Area A (Amblema plicata and Lampsilis radiata siliquoidea) with A. plicata vastly the dominant species. No charred gastropod or bivalve species were observed from any level. However, one Lampsilis sp. valve fragment had strange though evenly spaced notches along one edge. Judging from the number of aquatic species present, Levels 3-5 were extensively flooded. The species and individual numbers drastically increase through these same levels and similarly fall off through the levels above and below Levels 3-5.

Since none of the heaviliy-wooded habitat requiring snail species occurred at this unit, it can be assumed that the site area was primarily open terrain through the levels examined. Levels 3-5 that exhibited evidence of frequent flooding occurred in stratum 9.

Area B

One fire-charred unionid specimen was found in Level 16. Even more

so than at Area A, almost all levels exhibited indications of frequent flooding. This Area also must have been fairly open terrain as the dense woodland snail species (A. strongylodes, M. friabilis) were absent except at Level 19 (M. friabilis). In correlation with the soil zones, Molluscan density levels were the lowest in stratum 3 (also no evidence of flooding) and highest through stratum 5, although Levels 9-10 in stratum 4 also showed high density. The most active periods of flooding appear to have occurred through Levels 10 (stratum 4) and 15-19 (all of stratum 5).

Granger Reservoir Mollusca

Site 41WM122

Molluscan data from this site indicated a situation very similar in nature to site 41WM163. Amblema plicata was the dominant species and was recovered from all levels. Lampsilis radiata siliquoidea was recovered only in levels 1-3 and 7.

Tritogonia verrucosa was only in level 1 and in general surface collections. Cyclonaias tuburculata also was recovered only in general surface collections, from level 3 upward, both the number of species and of individuals increased,but no climatic trend can be inferred without more comparative levels.

Site 41WM124

Fire-blackened specimens of Amblema plicata were found in Levels 15 and 19 (Unit 801N/803W). One fire-blackened shell of the gastropod Anguispira strongylodes was found in Level 20 (Unit 801N/804W). Amblema plicata specimens were present in most levels. No climatic trends could be determined from the Area A unionid series.

The tremendous numbers of gastropod species and individuals recovered from Levels 19-22 (Unit 801N/803W) and Levels 19-21 (Unit 801N/804W) is unusual in Central Texas archaeological sites. This fact particularly applies to the large number of species present (14). The species assemblage from Area A included only one aquatic snail specimen which indicates that Site 41WM124 was heavily wooded particularly with the presence of P. auriformis and quite moist at least through the examined levels.

Areas A, B, and C cannot be statistically analyzed because no gastropods were collected from Areas B or C. Looking closer at Area A, it is interesting to note that overall distribution of species between adjacent 1 meter columns (i.e., Unit 801N/803W and 801N/804W) is highly variable; Unit 801N/803W being more abundant in numbers of species and numbers of individuals/species. Analysis of Levels 19, 20, 21 at both units resulted in specific deductions for each unit.

Overall Analysis of Site (by Area)

Simpson's Index

$$D = \frac{N(N-1)}{n(n-1)}$$

N = total # of individuals of all species
n = # of individuals of a species

1.0 = one species present
↑ = one individual/all species present

D of Area A = 3.494
D of Area B = 4.612
D of Area C - 2.944

Overall Analysis of Area A (by Unit)

Unit 801N/803W
D = 3.895

Unit 801N/804W
D = 2.847

Unit 801N/803W is more diverse than Unit 801N/804W. Why is there so much variability between adjacent columns? Obviously, the reoccurrence of Indians affected the diversity of snails present at both units; perhaps column 801N/803W was located on the perimeter of the hearth thus accounting for the denser distribution.

Column Analysis--Area A by separate Units

Unit 801N/803W
D (Level 19) = 3.445
D (Level 20) = 3.809
D (Level 21) = 3.759

Deductions:

1. Levels 20, 21 are equal in diversity.
2. Level 19 shows slight reduction in number's of species and number's of ind.

Unit 801N/804W
D (Level 19) - 2.113
D (Level 20) = 2.372
D (Level 21) = 3.93

Deductions:

1. Levels 19, 20 are equal in diversity.
2. Level 21 shows radical increase in number's of species.

Site 41WM163

Molluscan data from this site indicated no unusual human or climatic activity, although *Amblema plicata* was the numerically dominate unionid as was the case for all examined sites.

Several unionid species (Lampsilis radiata siliquoidea, Lampsilis teres and Ligumia nasuta) were recovered from backhoe trench collections that were not recovered from the test pits. The Cretaceous oyster recovered from Area B is a common Erxogyra sp. found in the exposed upstream limestone.

Ligumia nasuta was recovered only from this site and was previously unreported in literature records.

Site 41WM258

General

Bivalve data obtained from areas A, B and C indicate minimal human usage through all levels, both in terms of numbers of specimens and numbers of specimens and numbers of fire-charred specimens.

Area A

Only seven fire-charred bivalve specimens were found in the 121 specimens examined. The charred specimens were in levels 4, 5, and 7. Interestingly, five of the seven were Amblema plicata and only one was Lampsilis radiata siliquoidea (the seventh was an unidentifiable fragment) although 78 L. r. siliquoidea specimens were recovered and only 6 A. plicata.

No cultural significance could be derived from the above information. The entire site is reported to be frequently flooded and appears to be an area that would support a variety of lotic (stream) or lentic (pond) bivalve species. The numbers of species and individuals found at all levels are consistent and not at all indicative of flood deposition, which makes the ratio of A. plicata specimens to L. r. siliquoidea specimens quite interesting.

An overall analysis of site by area cannot be done because of biased results due to sampling error (i.e., no snails collected at Areas A or C). Furthermore, an overall analysis of site by specific areas is not possible because a continual column of snails and bivalve data is lacking. Therefore, a column analysis of each area is presented. At site 41WM124, Area A was statistically analyzed by separate units. Unfortunately, Site 41WM258 cannot be treated in the same manner because of low numbers of sample size (in which case no analysis was performed--Areas A and C) or lack of a continual column of snails and bivalve data (in which case all 5 units of Area B were collectively analyzed).

Area B (Levels 2-11)

The bivalve data from Area B are very similar to that of Areas A and C. One fire-charred specimen of A. plicata was found at level 3 and one L. r. siliquoidea at level 10.

Units [N976/W999, N976/W1000, N975/W999, N975/W1000, N974/W1000] When running species diversity indices on collective units we are assumming the following:

1. each level is stratigraphically the same.
2. distribution of species is the same regardless of the column (unit) sampled.*

*Something we proved incorrect in Site 41WM124 when analyzing the site by specific unit (i.e., Site A N801/W803 was much more diverse th n Area A, Unit N801/W804).

$$D) = \frac{N(N-1)}{n(n-1)}$$

D) Level 2 = 3.121
D) Level 3 = 2.350
D) Level 4 - 2.568
D) Level 5 = 2.015
D) Level 6 = Not run due to no snail samples
D) Level 7 = 2.381
D) Level 8 = 1.789
D) Level 9 = 1.313
D) Level 10 = 1.797
D) Level 11 = 2.306

Level 9--D = 1.313 which tells us the majority of ind. belongs to one species (H. o. tropica)
Level 2--D = 3.121, no indication of human activity at level 2; to perhaps represents a drier climate.
Level 3--

When no cultural material was collected, we can assume that humans were not present at the site at that time (i.e., Level 11). Cultural material collected in levels 3-9 indicates human activity and a substantial drop in species diversity. We can see the impact of humans on the environment even 480 years ago. As humans moved in, species diversity was decreased (just as we are addressing this problem today).

Area C (Levels 4-8, 10-13)

The bivalve data obtained from this area are quite similar to that

of Area A, particularly in the numbers of species. L. r. siliquoidea and L. teres were again the dominates. In fact, only one specimen of A. plicata was found (Level 5). One unidentifiable fire-charred bivalve fragment occurred at level 11. Interestingly, most specimens recovered from all levels were whole valves which is not the usual norm. Unfortunately, most site bivalve specimens are mostly broken.

Site 41WM230

4,128 gastropods were examined from the site. No aquatic species were recovered indicating that the site was infrequently flooded. Furthermore, only 571 bivalves were recovered with 208 unidentifiable fragments compromising the most numbers of the six species identified. Also, all bivalve species are shallow, running water species. It would be suspected that most of the bivalves were hand carried onto the site.

The site must have been located in or very close to a densely wooded area. 2,998 of the 4,128 recovered gastropods (A. alternata, H. o. tropica, M. friabilis, S. texasiana, and M. roemeri) are deep woodland species, although more (seven) drier area tolerant species were present.

Climatically, the molluscan data presents an interesting but perplexing picture. It should be mentioned at this point that all mollusks at each level were counted which may give a bias to the data as all quadrats were not available and counted for each level. It should also be mentioned that levels 2-12 (N1022/W996) is separated from the remaining adjacent quadrants by one meter. However, some speculations may be made from the available molluscan data.

The area was obviously drier from levels 49 through level 33. From that level a wetter, though fluctuating period must have occured up to level 12. Although apparently still fluctuating, the climate must have continued to become wetter, except from levels 3-4. Further evidence for a wetter period upwards is reflected in the population level fluctuations of one xeric species (R. d. dealbatus) and several of the more moisture requiring species (A. alternata, M. friabilis, and H. o. tropica). R. d. dealbatus population levels per level decrease upward while the "wetter" species population densitites increase upward. In fact, except for sporadic occurrences at levels 26-27, A. alternata disappears after level 22. The same situation applies to M. friabilis which disappears after level 14 but, again with only spotty occurrences downward.

Thus overall, Site 41WM230 compares favorably with projected climatic conditions obtained from data from other area sites examined. The climate at the lower levels was unquestionably drier than at the upper levels. The area immediately adjacent to the site was densely wooded with very little open or grassy areas (reason for low numbers of R. d. dealbatus). The only molluscan data changes as well as an

indication of climatic change occured at level 12. No evidence of human impact at the site could be determined from the molluscan data.

Site 41WM267

Area A

The four Units from Area A were first examined individually, and then collapsed as only Unit 1001N/989W (Levels 2-26) had gastropod material. Fire-charred bivalve specimens were found in Levels 12, 14-15, 18-21. Only two (Amblema plicata, Lampsilis radiata siliquoidea) species had charred specimens of the five identified from the Area. Like Areas B and D, A. plicata was the dominant species with charred specimens. No bivalve specimens were found above Level 6. The number of gastropod species/ level also drops above Level 5 although numbers of individuals drops above Level 6. It should be stated at this point that the snail column of Unit 1001N/989W is a classical example of snail deposition occurring without being significantly flood influenced at any level. Only one aquatic snail specimen was found in material examined from the entire site. Thus, fluctuations in species and individual numbers can be considered to be caused by climatic changes or by human impact.

First raw data examination of the gastropod species and individual numbers/level from Unit 1001N/989W revealed erratically fluctuating numbers between many levels, typical of a frequent flood influenced situation. However, as previously stated, no aquatic gastropods were found in the entire column and even the bivalve fauna remained consistent in species composition.

A unique picture emerged when the snail population densities/ level of six snail species were graphed and compared to the levels where human activity unquestionably occurred (Figure 15.6-1). At each of the established human activity levels (12, 14-15, 18-21), the gastropod population densities noticeably declined and consistently expanded through the "quiet" levels. Total bivalve specimen numbers/ level inversely corresponded to the gastropod population densities/ level, which strongly suggests that the mussels were human transported into the area. Debitage totals/level also roughly correspond to the overall gastropod population density changes/level (Table 8.10-5).

Climatic conditions and fluctuations can, at best now, be roughly determined by analysis of gastropod species composition/level and not much by individual numbers in light of the just discussed discovery of established human impact on the molluscan populations. Dense woodlands must have closely surrounded the Area with the presence of such habitat requiring species (A. strongylodes, M. friabilis, M. roemeri). Since A. stronglylodes is absent from Levels 14-16 and 18 downward and M. friabilis from Level 11 downward, the overall climate must have been drier through these levels (or the Indians burned most of the fallen wood). No meaningful observations could be determined when the molluscan

data was compared to soil zone 4 (Levels 15-22) except that human activity was highest through the zone as was the case in Area D.

In conclusion, continued excavation of a Unit (going through a hearth at least) possibly can be determined by observation of gastropod population density trends through preceeding levels. From the molluscan information derived from Area A, excavation of a unit outside the site area is highly desirable. How do human uninfluenced molluscan density changes compare with now known density changes under human impact.

Area B

The six Units were first examined individually and then collapsed into a single column. Fire-charred specimens were found in Levels 6, 10-15, 18, 20-23. Only two out of the 8 identified species had charred pieces (Amblema plicata and Lampsilis radiata siliquoidea) with A. plicata dominant numerically. See the chart for specific Units containing fire-charred specimens. A series of charred Lampsilis umbos from Unit 1017N/986W (NW)--Level 16 are illustrated to show the typical shape of all the charred Lampsilis specimens examined from Area B. As in Area C, bivalve specimens were most numerous in the levels showing human activity. This data is particularly significant because with eight species identified from the Area, it is strongly suspected that this particular area underwent some degree of flooding or at least more so than Area A within the site.

Area C

One fire-charred valve of Amblema plicata was observed at Unit 1001N/1009W--Level 8. Lampsilis radiata siliquoidea, however, was the numerically dominant bivalve. Specimens were most numerous at Levels 6-7 and drastically drop off below Level 8 where the fire-charred valve occurred. The numbers also drop drastically at Level 5-2. No particular climatic trends could be determined from the available material.

Area D

Again, the eight Units were first examined individually and then collaps-d into a single column. Fire-charred bivalve specimens were observed in Levels 4-9, 11, 14, 18, and 24 (see chart for specific Units). Levels 14 and 18 were the most active areas in terms of charred specimens and Amblema plicata was easily the dominant of the two species (Lampsilis radiata siliquoidea) with charred specimens. A total of six species were identified from Area D. Unlike Areas C and B, the levels showing human activity did not also contain the most numbers of total specimens through the levels. Although no snail species or numbers were available for the levels showing no human activity, the species and individual

numbers in the human activity levels of Area D compared very close to similar levels in Area A. Both number series drop in these levels, particularly the number of species.

Most of the fire-charred specimens occurred through the levels (2-12) of soil zone 4. No correlation, however, could be determined between the molluscan data/level and debitage totals/level.

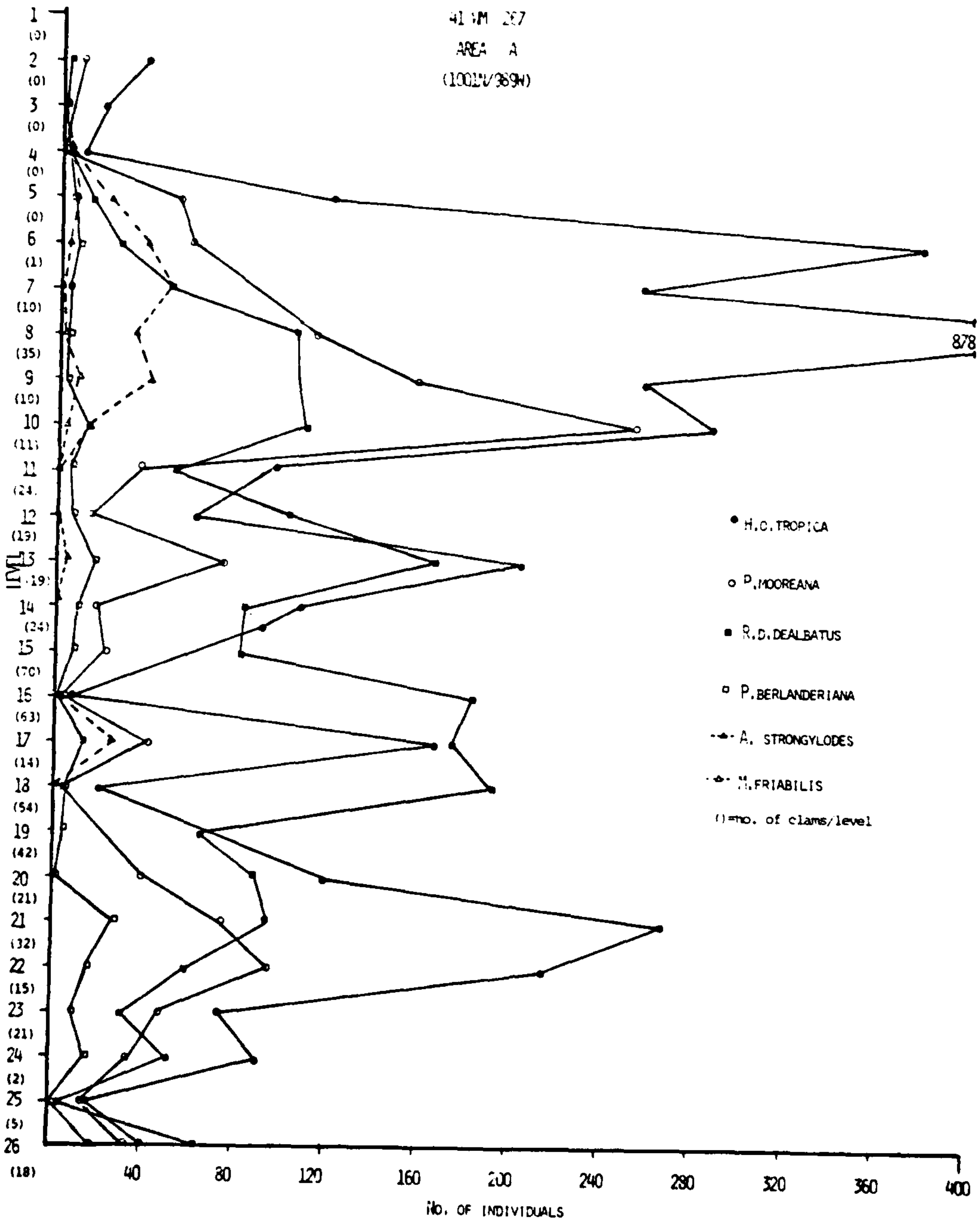

Figure 15.6-1

15.7 Vertebrate Faunal Remains

by

Bonnie C. Yates

Introduction

Ethnozoology may be defined as the study of human subsistence on animal resources or, more specificially, "the relationship between animal species and man within the bounds of a particular culture" (Cleland 1966: 37). This study of the faunal remains recovered from 8 to 32 prehistoric sites tested and excavated during the San Gabriel Archaeological Project provides an opportunity to add information to the understanding of human cultural evolution in Central Texas by 1) identifying the animals utilized by the prehistoric inhabitants of the area; 2) analyzing the changes in cultural exploitative strategies based on relative frequencies of identified animal remains; and 3) making inferences regarding season of occupation and nutritional contributions based on selected species.

Identification of animal remains and formulation of a species list are crucial first steps in faunal analysis of any prehistoric site. Knowing the kinds of animals and where they are hunted enables the analyst to reconstruct (somewhat) the local environment and not changes in such cultural characteristics as butchering and cooking habits, as well as suggest settlement patterns and duration of occupation. Comments on the health and nutrition of the aboriginal occupants may also be made. Because so many subsistence details depend on knowledge of the animals represented in the sample, consistency in identification is paramount. All of the bones were identified solely and consistently by the author using the comparative collection at NTSU and osteological manuals such as those by Schmid (1972), Gilbert (1973), Lawrence (1951), and Olsen (1960, 1964, 1968).

Table 15.7-1 is a comprehensive species list of all identified vertebrates from sites excavated during this project. The six general habitat preferences are modified from a scheme by Gilbert (1973) who adapted his distribution of mammals in biotic communities after Jones (1964). Table 15.7-1 is expanded to include habitat information for all of the vertebrate class but reduces the number of habitats to those common to the San Gabriel area. Basically, these habitat preferences can be further lumped into three biomes: aquatic (water/shore); woodland (streamside treeline and meadow); and prairie (scrub thicket, rock outcrop and grasslands). Determination of habitat preference for each species is based on various references: Peterson Field Guides, (Peterson 1963; Conant 1975; Burt 1952); The Mammals of Texas (Davis 1974); Turtles of the U.S. (Ernest and Barbour 1972); Birds of North America (Robbins et al. 1966); Freshwater Fishes of Texas (Kemp 1971); and various site reports including Johnson (1976), Cleland (1966) and Duffield (1970).

Table 15.7-1. Identified Vertebrates from San Gabriel Archaeological Sites.

	GENERAL HABITAT PREFERENCE					
	WATER/SHORE	MEADOW	STREAMSIDE TREELINE	SCRUB THICKET	ROCK OUTCROP	GRASSLAND
MAMMALS						
Opossum *Didelphis virginiana*		x	x			
Least shrew *Cryptotis parva*		x				x
Short-tailed shrew *Blarina brevicauda*	x	x		x		
Bat sp. *Chiroptera*						
Nine-banded armadillo *Dasypus novemcinctus**						
Cottontail rabbit *Sylvilagus* cf. *floridanus*		x	x			
Black-tailed jackrabbit *Lepus californicus*				x	x	x
Black-tailed prairie dog *Cynomys ludovicanus*						x
Fox squirrel *Sciurus* cf. *niger*			x	x		
Ground squirrel *Citellus* sp.						x
Pocket gopher *Geomys* cf. *bursarius*	x					x
Pocket mice *Perognathus* spp.				x	x	
Beaver *Castor canadensis*	x					
Harvest mouse *Reithrodontomys* sp.		x				x
White-footed mice *Peromyscus* spp.						
N. Grasshopper mouse *Onychomys leucogaster*				x		x
cf. Pygmy mouse *Baiomys taylori*						x
Cotton rat *Sigmodon hispidus*				x		
Woodrat *Neotoma* sp.						
Vole *Microtis* sp.			x			
Dog/coyote *Canis* spp.		x	x	x		x
Raccoon *Procyon lotor*	x	x	x			
Badger *Taxidea taxus*						x
cf. Bear *Ursus americanus*			x			

Table 15.7-1
(continued)

	GENERAL HABITAT PREFERENCE					
	WATER/SHORE	MEADOW	STREAMSIDE TREELINE	SCRUB THICKET	ROCK OUTCROP	GRASSLAND
Skunk *Mephitis* cf. *mephitis*			x	x	x	x
cf. Puma *Felis concolor*						
Gray Fox *Urocyon cinereoargenteus*		x	x			
White-tailed deer *Odocoileus virginianus*			x	x		
Pronghorn antelope *Antilocapra americana*						x
Goat *Capra hirca*						
Cow/bison *Bos/Bison*						x
Pig *Sus scrofa**						
Human *Homo sapiens*						
BIRDS						
Turkey *Meleagris gallopavo*		x	x	x		
Prairie chicken *Tympanuchus* sp.						x
Bobwhite *Colinus virginianus*		x		x		x
Teal *Anus* cf. *carolinensis*	x					
Duck/Goose *Anatidae*	x					
Hawk *Buteo* sp.						
Owl sp. *Strigiformes*						
Crow *Corvus* sp.		x	x	x		
cf. Brown thrasher *Toxostoma rufum*				x		
cf. Cardinal *Richmondena cardinalis*				x		
cf. Lark sparrow *Chondestes grammacus*				x		
Warbler sp. *Parulidae*						
Robin *Turdus migratorius*						
cf. Spoonbill *Ciconiiformes*						
Vulture *Cathartidae*						

Table 15.7-1
(continued)

	GENERAL HABITAT PREFERENCE					
	WATER/SHORE	MEADOW	STREAMSIDE TREELINE	SCRUB THICKET	ROCK OUTCROP	GRASSLAND
REPTILES						
Viper spp. *Viperidae*						
Colubrid sp. *Colubridae*						
Hog-nosed snake *Heterodon* sp.						
Rat snake *Elaphe* sp.						
Box turtle *Terrapene* sp.	x	x	x			
Pond Slider *Chrysemys* sp.	x					
Musk/Mud turtle sp. *Kinosternidae*	x					
Softshell turtle *Trionyx* sp.	x					
Lizard sp. *Iguanidae*						
AMPHIBIANS						
Bullfrog *Rana catesbiana*	x					
Toad/frog sp. *Anura*	x	x	x			
Salamander sp. *Caudata*	x		x			
FISHES						
Gar *Lepisosteus* sp.	x					
Catfish *Ictalurus* sp.	x					
Freshwater drum *Aplodinotus grunniens*	x					
Bass/Sunfish sp. *Centrarchidae*	x					

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*historic

In general, habitats are dictated by edaphic and climatic conditions. Environmental aspects of the project area are treated in detail elsewhere in this volume. The important fact for this report is that each reservoir is in a different biotic province--North Fork is placed in the eastern extreme of Blair's (1950) Balconian province and part of the Central Texas section of the Great Plains physiographic region. Granger reservoir is part of the western extreme of the Texas province (Blair 1950; Dice 1943) and forms part of the Blackland Prairie in the Gulf Coastal Plains physiographic region. Ideally, faunal remains should reflect intrinsic qualities of their respective biotic provinces. Unfortunately, the qualitative differences in the faunae (if not in other aspects like soils or vegetation) are not clearcut. Furthermore, both biotic provinces are considered ecotones with many shared species.

The expected potential for zoological diversity between the reservoirs is diminished even though each reservoir is in a different biotic province. In Blair's words,

> A great area in central Texas, from the Pecos on the west to the western boundary of the Austrotiparian forest on the east, is principally a region of transition between the Sonoran and Austroriparian biotas. In this area the two major biotic elements intermix or interdigitate. (1950: 95)

This intermingling is the result of the wooded areas which flank the major river systems and allow westward expansion of eastern forms and vice-a-versa. Blair also implies that local conditions can be quite diverse, allowing for more mesic or zeric environments than the regional average. In addition to this "hodgepodge" of habitats, the Balconian province has only one endemic vertebrate group, the urodeles (specifically certain cave salamanders), and the Texas province has no endemic species (Blair 1950). These problems are magnified in Williamson County where the eastern edge of one province meets the western edge of the other. Table 15.7-2 lists (A) mammaliam species that are currently found in Williamson County and (B) those species represented in the archaeological samples that do not now occur naturally in the county. Checked species indicate animals that are represented in the archaeological samples.

Assessment of seasonality and nutritional contribution of animal resources are aspects of faunal analysis also based on identified species. Knowledge of migratory fowl, hibernation patterns, deer dentition and antler shedding can assist in determining seasonality. Unfortunately, here again these samples proved inadequate for each consideration. For example, poor preservation hampered identification of the scant bird bones recovered. Cold temperature stress in Central Texas is generally insufficient to generate hibernation stimulus. The presence of very young deer (determined by dentition) can be used to figure minimum seasonal occupation, but duration of occupation remains a problematic variable. The condition of antlers prior to shedding is also useful in seasonality determination, but none of the antlers in this collection have the pedicle intact, and therefore, may have been shed at any time and picked up at any time.

Table 15.7-2

A. Non-domestic Mammals with Current Ranges in Williamson County, Texas

SPECIES	SCIENTIFIC NAME	√=ARCHAEOLOGICAL SPECIMEN IDENTIFIED
Oppossum	*Didelphis virginiana*	√
Eastern mole	*Scalopus aquaticus*	√
Desert shrew*	*Notiosorex crawfordi*	
Least shrew	*Cryptotis parva*	√
Nine-banded armadillo	*Dasypus novemcinctus*	I
Cave bat	*Myotis velifer*	
Georgia bat	*Pipistrellus subflavus*	
Hoary bat	*Lasiurus cinereus*	√
Red bat	*Lasiurus borealis*	
Guano bat	*Tadarida mexicana*	
Mexican ground squirrel	*Spermophilus mexicanus*	?
Fox squirrel	*Sciurus niger*	√
Plains pocket gopher	*Geomys bursarius*	√
Merriam pocket mouse*	*Perognathus merriami*	
Hispid pocket mouse	*Perognathus hispidus*	√
Beaver	*Castor canadensis*	√
Fulvous harvest mouse	*Reithrodontomys fulvescens*	√
Plains harvest mouse	*Reithrodontomys montanus*	
Pygmy mouse	*Baiomys taylori*	√
Deer mouse	*Peromyscus maniculatus*	√ or
White-footed mouse	*Peromyscus leucopus*	√
Texas mouse*	*Peromyscus attwateri*	
Encinal mouse	*Peromyscus pectoralis*	
Hispid cotton rat	*Sigmodon hispidus*	√
Florida woodrat	*Neotoma floridana*	√
Old world mice & rats	*Muridae*	I
Nutria	*Myocastor coypus*	I
Blacktail jackrabbit	*Lepus californicus*	√
Eastern cottontail	*Sylvilagus floridanus*	√
Swamp rabbit**	*Sylvilagus aquaticus*	

Table 15.7-2
(continued)

SPECIES	SCIENTIFIC NAME	✓=ARCHAEOLOGICAL SPECIMEN IDENTIFIED
Raccoon	*Procyon lotor*	✓
Ringtail	*Bassariscus astutus*	
Long-tailed weasel	*Mustela frenata*	
Mink	*Mustela vision*	?
Striped skunk	*Mephitis mephitis*	✓
Badger	*Taxidea taxus*	✓
Red fox	*Vulpes fulva*	I
Gray fox	*Urocyon cinereoargenteus*	✓
Coyote	*Canis latrans*	?
Red wolf	*Canis rufus*	
Cougar	*Felis concolor*	?
Bobcat	*Lynx rufus*	✓
White-tail deer	*Odocoileus virginianus*	✓

* Current range limit near North Fork reservoir.

** Current range limit near Granger Reservoir.

I Known intrusive or recently introduced species.

B. Archaeological Specimens of Mammals Not Currently Found in Williamson Co.

Short-tail shrew	*Blarina brevicauda*
Vole sp.	*Microtus sp.*
N. grasshopper mouse	*Onychomys leucogaster*
Black-tail prairie dog	*Cynomys ludovicianus*
Black bear	*Ursus americanus*
Pronghorn	*Antilocapra americana*
Bison	*Bison bison*

References: Hall and Kelson (1959), Davis (1974).

With similar problems, nutritional contribution can be projected only on a relative basis because so many taphonomic and mitigational contingencies are involved. Nutritional assessment is derived from estimating the amount of meat or vegetation food energy available and/or consumed by the occupants of a site. Zooarchaeologists make meat protein estimates based on relative abundance of each species either by counting identified elements, weighing all the bones for each species, or by establishing minimum numbers of individuals. Each method has limitations and each is subject to invalidation caused by the mechanisms of burial (taphonomy) and sampling procedures. Both factors affect the amount of bone recovered by archaeological investigation. An example of the arbitrary effects of taphonomy is demonstrated by analysis of the contents of certain hearths in which some hearths were full of cultural materials while others were practically empty perhaps caused by the scouring action of torrential floods or "housekeeping" habits of the sites occupants. Time strictures, furthermore, required that mitigation efforts be directed toward obtaining materials from more sites rather than extensive excavations at particular sites. The results are widely varying sample sizes. The likelihood is minimal that any osteological sample accurately reflects the true quantities of utilized species.

In summary, analysis is limited by what is excavated, identification consistency, differential preservation, cultural preference and natural abundance of species. All of these factors affect the amount of knowledge gleaned from archaeological faunal assemblages to some degree. Comparing components within sites and using density of elements per species per cubic meter of fill helps balance the sample size problem. Having one person responsible for identifications enhances consistency. The quality of preservation is equally poor to fair for all of the sites. Therefore, the relative frequencies of species' elements probably reflect aboriginal utilization based on a combination of cultural preference and natural abundance. These last two factors form the focus of this report.

Methodology

Some 111,266 fragments of bone were examined from the San Gabriel project sites, 50,804 from North Fork and 60,462 from Granger. Osteological material from both reservoirs was processed in the same manner. In the field, all excavation fill was screened through ¼" mesh and 25% of each excavation unit was fine screened through 1 mm mesh. All feature matrices were fine screened. This screening scheme assured a consistent sampling of faunal remains from very small vertebrates (e.g., insectivores, small birds, and fishes) as well as tiny, but diagnostic elements such as loose teeth. Some elements required stabilization prior to removal from the ground. This was accomplished by using a solution of Duco (TM) cement and acetone (1:10). Most of the bones near the water table (specifically the lower levels of 41WM267) needed this treatment which hastened moisture loss, thus enabling expeditious extraction from the wetter clays. Because of the quick dry effect, these elements fragmented easily during later analysis. However, exemplary packaging and careful handling in the field lab kept these fragile bones intact enough for sufficient examination.

All of the bone was washed and separated from other materials in the field lab and bagged by quad and level with the appropriate provenience label. In the analysis lab, the bones from each bag were separated as identifiable and unidentifiable, then counted as burned or unburned. All of these details were catalogued by site, area, unit, quad, level and noted as coming from fine screen materials and/or feature material. A labeling scheme was devised in order to write important provenience information directly onto the identifiable bones. Because horizontal provenience often contained up to 9 digits, the catalog number was used instead. Usually 2 rows of information were written on each bone or, in the case of tiny elements, onto a triple "o" gelatin capsule. This information includes 1) the site number-excavation area (given as a number) and 2) the catalog number/level number. This labeling technique permits separating the elements from the unidentifiable fragments and manipulating groups of species by level without losing provenience.

With a few notable exceptions, vertical provenience is given preeminence when quantifying the number of bone fragments for the analysis. The appendices for this report give total number of fragments per level per excavation area for every site yielding bone. Quantification by hortizontal provenience (i.e., by 1 x 1 m^2 units) are presented for those features designated as osteological features (e.g., the "bone bed" in Feature 9 at 41WM267). Otherwise horizontal (unit) provenience for identified bone may be obtained by referring to the catalog number.

The identified sample was sorted by species and quantified by cultural component as designated by the excavators. For example, if levels 4 and 5 at a certain excavation area contain projectile points associated with the Round Rock "phase", then all of the identified elements from levels 4 and 5 in that area are quantified for the Round Rock component. Admittedly, this system is somewhat arbitrary and lacks assurance that level contamination does not occur between components. With few exceptions, however, total bone counts per level generally agree with component designations. In other words, bone counts per level increase and decrease as one component begins and ends (See Appendix C). A system like this is necessary in order to present the faunal analysis on a consistent basis with the lithic analysis.

In addition, this system provides a basis for tabulating estimated minimum numbers of individuals per species (MNI). Estimating MNI per level is inadequate when sample sizes are small because in one level a single element may represent one individual, yet in another level, 12 unrepeated elements may also represent only one individual. If the MNI estimates for all of the levels in one component are summed, the estimate may be too high, especially when deposition rates are unknown. In the same way, MNI based on lumped levels (or components) may be too low, but without calculating deposition rates, the minimum MNI is preferred. Considering, therefore, the basic problems with minimum number estimates, they are calculated in this report for mammals only and solely for the purpose of convention. When more than one individual is figured for a species, the determining element(s) and other pertinent information will be noted.

Besides MNI, other aspects of terminology and report rationale require brief mention. For example, the term fragment is used for any piece of bone that is not whole and more specifically for unidentifiable pieces. The term element is restricted to a specific skeletal body part (e.g., femur, phalange), complete or fragmented, from which identification to some degree of taxonomy is possible. In some cases, non-diagnostic or badly fragmented elements can be identified only to vertebrate class and then categorized by size.

Four size categories are used in this report for mammals. They include 1) rodent, consisting of very small mammal elements from unspecific mice, rats, and probably small squirrels; 2) small, consisting of elements from mammals no smaller than fox squirrels and no larger than jackrabbits; 3) medium, including elements that could be from large skunks, opossum, raccoons, beaver, badgers, or dogs; 4) large, consisting of elements probably from ungulates such as bison, pronghorn, or deer.

Except for dentition, pronghorn is extremely difficult to distinguish from deer when their osteological remains are fragmentary and poorly preserved. It is quite possible that a few broken elements quantified as deer are in reality pronghorn. Considering the immense effort required to fell a running pronghorn, which can attain speeds up to 54 mph/86 kmph, (Shelford 1963), the occupants probably utilized this animal infrequently. Therefore, the relative proportions of deer to pronghorn as calculated most likely reflect the appropriate degree of utilization.

As another example, bison bones in general are easily distinguished by bone wall thickness and overall size. Based on massive size and not necessarily element morphology, non-element fragments were counted as identified bison. Skewing is unlikely because very few of these huge elements remained intact, and the low quantities of fragments suggest only occasional consumption of this prairie species anyway.

Finally, if there was any doubt as to an element's specific origin, especially fragments of tooth enamel, the piece was quantified with its appropriate size category. These often troublesome elements cannot be ignored and therefore are utilized in the analysis in this manner.

The format of each site description is structured around analysis of the identified species, although consideration of the unidentified sample and size of the total osteological sample is given. Basically, each site is described first according to general comparisions of each excavation area and their respective component constituents, spatial relationships and total amount of faunal material. Then the species composition of each cultural component is described, including density of bone and highlighting habitat types and vertebrate classes. Also included are comments on butchering and burning patterns, as well as consideration of anatomical parts present in the sample or conspicuously absent. Comparisons between components are included, and inferences

regarding habitat utilization are made when possible. Because archaeological samples are culturally biased and subject to taphonomic contingencies, "species diversity" is used in this report as a relative comparison of the total number of taxa recognized for each component instead of the standard ecological indexes used for comparing natural communities.

Following this introduction, a series of tables (Tables 15.7-A through I) are provided as species list for each cultural component and the sites at either reservoir which contain zones associated with these cultures. The total number of identified elements for each taxa is given along with relative frequency. These tables will be referenced throughout the site discussions. Tables within each site report describe the contents of every component within each excavation area of the site under discussion. These tables provide data for horizontal consideration as well as vertical provenience and indicate how many of the total elements assigned to each taxa are loose dental elements (T) and how many elements are burned (B) in addition to density and MNI estimates.

Unfortunately, small sample size prohibits elaborate statistical manipulations and renders unrealistic minimum numbers estimates (Munson and Limp, n.d.). Very few component samples or species samples from these sites are of adequate size for intersite comparisons. A Pinkham and Pearson (1974) cluster analysis was performed based on density of identified fragments per species by cultural component, but the results showed very little correlation between any component. Only one set of values correlated in excess of .4 and that was between two Neo-American components at the same site. Therefore, little attempt at much more than gross comparisons and data presentation is deemed necessary for faunal materials from so many multi-component sites. Subsequent to this initial documentation of these findings, future detailed analysis of particular samples is suggested.

TABLE 15.7-A FAUNAL LISTS BY COMPONENT TOYAH

Granger Sites

41WM230 - XU 8

Taxa	n	%
Opossum	1	3.7
Deer Mouse	1	3.7
Cotton Rat	1	3.7
Dog/Coyote	11	55.5
White-tailed deer	1	3.7
Cow/Bison	2	7.4
Element: rodent	6	22.2
Totals	27	100.0

41WM258 - Areas A & B

Taxa	n	%
Opossum	3	1.77
Cottontail Rabbit	2	1.18
Fox Squirrel	2	1.18
Pocket Gopher	15	8.87
Cotton Rat	10	5.91
Woodrat	2	1.18
White-tailed deer	56	33.13
Cow/Bison	33	19.52
Elements: rodent	2	1.18
-Medium	1	0.59
-Large	4	2.36
Snake sp.	1	0.59
Viper	1	0.59
Coluber	3	1.77
Turtle sp.	16	9.46
Box Turtle	7	4.14
Bullfrog	1	0.59
Toad/Frog	2	1.18
Fish sp.	5	2.95
Gar	1	0.59
Catfish	2	1.18
Totals	169	100.00

TABLE 15.7-B FAUNAL LISTS BY COMPONENT AUSTIN

Granger Sites

41WM258 - Areas A & B

Taxa	n	
Opossum	1	1.92
Cottontail Rabbit	3	5.76
Pocket Gopher	5	9.61
Cotton Rat	1	1.92
Dog/Coyote	1	1.92
White-tailed deer	37	71.15
Cow/Bison	1	1.92
Turtle sp.	3	5.76
Totals	52	100.00

41WM230 - XU 1 & 5

Taxa	n	
Cottontail Rabbit	2	1.22
Fox Squirrel	2	1.22
Pocket Gopher	16	9.75
Pocket Mouse	3	1.82
Beaver	1	0.61
Deer Mouse	3	1.82
Pygmy Mouse	1	0.61
Cotton Rat	10	6.09
Vole	2	1.22
Dog/Coyote	1	0.61
White-tailed deer	17	10.36
Elements: rodent	54	32.92
-Medium	2	1.22
-Large	5	3.04
Perching Birds	3	1.82
Snake sp.	9	5.48
Viper	2	1.22
Coluber	8	4.87
Turtle sp.	11	6.70
Lizard	1	0.61
Toad/Frog	6	3.65
Fish sp.	5	3.04
Totals	164	100.00

North Fork Sites

41WM53 - Areas A & B

Taxa	n	
Fox Squirrel	1	4.76
Pocket Mouse	1	4.76
White-tailed deer	14	66.66
Elements: small	1	4.76
-Large	[illegible]	4.76
Turtle sp.	2	9.52
Fish sp.	1	4.76
Totals	21	100.00

TABLE 15.7-C FAUNAL LISTS BY COMPONENT AUSTIN/TOYAH

Granger Sites

41WM124 - Areas A & B

Taxa	n	%
Cottontail Rabbit	1	5.00
Squirrel	1	5.00
Pocket Gopher	1	5.00
Beaver	1	5.00
Cotton Rat	1	5.00
White-tailed deer	8	40.00
Prairie chicken	1	5.00
Snake sp.	1	5.00
Viper	1	5.00
Turtle sp.	3	15.00
Fish sp.	1	5.00
Totals	20	100.00

41WM230 - XU 1 & 3

Taxa	n	%
Opossum	33	4.59
Least Shrew	8	1.11
Short-tailed shrew	3	0.41
Cottontail Rabbit	13	1.80
Jackrabbit	1	0.13
Fox Squirrel	10	1.39
Pocket Gopher	30	4.17
Pocket Mouse	6	0.83
Harvest Mouse	1	0.13
Deer Mouse	4	0.55
Grasshopper Mouse	3	0.41
Pygmy Mouse	2	0.27
Cotton Rat	154	21.41
Woodrat	6	0.83
Vole	14	1.94
White-tailed deer	50	6.95
Pronghorn	1	0.13
Cow/Bison	17	2.36
Elements: rodent	179	24.89
-Small	21	2.92
-Medium	10	1.39
-Large	3	0.41
Bobwhite	2	0.27
Perching Birds	2	0.27
Turkey	1	0.13
Cardinal	1	0.13
Bird-medium	2	0.27
Snake sp.	23	3.19
Viper	10	1.39
Coluber	62	8.62
Turtle sp.	3	0/41
Musk/Mud Turtle	1	0.13
Lizard	15	2.08
Toad/Frog	7	0.97
Salamander	1	0.13
Fish sp.	10	1.39
Rat Snake	7	0.97
Owl	1	0.13
Crow	1	0.13
Thrasher	1	0.13
Totals	719	100.00

TABLE 15.7-D FAUNAL LISTS BY COMPONENT TWIN SISTERS

Granger Sites

41WM124 - Areas A & B

Taxa	n	%
Opossum	2	0.75
Cottontail Rabbit	11	4.13
Jackrabbit	9	3.38
Pocket Gopher	13	4.88
Beaver	3	1.12
Deer Mouse	1	0.37
Cotton Rat	3	1.12
Woodrat	1	0.37
Vole	6	2.25
Raccoon	1	0.37
White-tailed deer	95	35.71
Elements: rodent	15	5.63
-small	1	0.37
-medium	7	2.63
-large	3	1.12
Snake sp.	19	7.14
Viper	23	8.64
Coluber	23	8.64
Hod-nosed snake	1	0.37
Turtle sp.	18	6.76
Yellow Mud Turtle	1	0.37
Toad/Frog	2	0.75
Lizard sp.	1	0.37
Salamander sp.	1	0.37
Bird sp.	3	1.12
Turkey	1	0.37
Fish sp.	1	0.37
Gar	1	0.37
Total	266	100.00

41WM267 - Area B & D

Taxa	n	%
Opossum	1	0.47
Cottontail Rabbit	1	0.47
Pocket Gopher	19	8.96
Pocket Mouse	5	2.53
Harvest Mouse	1	0.47
Deer Mouse	2	0.94
Cotton Rat	48	22.64
Woodrat	7	3.30
Vole	1	0.47
White-tailed deer	30	14.15
Elements: rodent	47	22.17
-small	1	0.47
-medium	1	0.47
-large	5	2.35
Prairie Chicken	1	0.47
Lark Sparrow	1	0.47
Snake sp.	7	3.30
Coluber	15	7.07
Turtle sp.	6	2.83
Lizard	4	1.88
Toad/Frog	5	2.35
Fish sp.	3	1.41
Gar	1	0.47
Total	212	100.00

41WM230 - XU 1 & 3

Taxa	n	%
Opossum	64	3.64
Least Shrew	8	0.45
Bat	1	0.05
Cottontail Rabbit	38	2.16
Jackrabbit	6	0.34
Fox Squirrel	13	0.74
Pocket Gopher	15[illegible]	8.54
Pocket Mouse	31	1.76
Beaver	6	0.34
Harvest Mouse	3	0.17
Deer Mouse	18	1.02
Grasshopper Mouse	4	0.22
Pygmy Mouse	[illegible]	0.28
Cotton Rat	13[illegible]	7.51
Woodrat	3	0.17
Vole	45	2.58
Dog/Coyote	12	0.68
Raccoon	1	0.05
White-tailed deer	214	12.27
Pronghorn	2	0.11
Cow/Bison	4	0.22
Elements: rodent	424	24.32
-small	40	2.27
-medium	8	0.45
-large	21	1.19
Bird-small	4	0.22
Bird-medium	5	0.28
Turkey	1	0.05
Prairie Chicken	5	0.28
Bobwhite	1	0.05
Perching Birds	6	0.34
Cardinal	1	0.05
Thrasher	1	0.05
Warbler	3	0.17
Snake sp.	83	4.76
Viper	63	3.61
Coluber	132	7.57
Hog-nosed snake	3	0.17
Rat Snake	1	0.05
Turtle sp.	54	3.09
Pond Slider	7	0.40
Box Turtle	2	0.11
Musk/Mud Turtle	3	0.17
Softshell Turtle	2	0.11
Lizard	14	0.80
Bullfrog	2	0.11
Toad/Frog	21	1.20
Fish sp.	74	4.24
Gar	1	0.05
Catfish	2	0.11
Total	1743	99.77

41WM258 - Areas A,B,C

Taxa	n	%
Rabbit	1	2.94
White-tailed deer	26	76.47
Elements: rodent	1	2.94
-medium	1	2.94
Viper	1	2.94
Turtle sp.	2	5.88
Box Turtle	3	8.82
Total	35	100.00

TABLE 15.7-D continued

North Fork Sites

41WM56 - Areas A & F

Taxa	n	%
Cottontail Rabbit	3	4.110
Pocket Gopher	1	1.370
Dog/Coyote	2	2.740
White-tailed deer	27	36.986
Cow/Bison	5	6.849
Elements: small	4	5.479
-Medium	1	1.370
-Large	19	26.027
Turtle sp.	7	9.589
Fish sp.	1	1.370
Catfish	3	4.110
Totals	73	100.000

41WM53 - Areas A,B,C

Taxa	n	%
White-tailed deer	14	82.353
-Large	2	11.765
Turtle sp.	1	5.882
Totals	17	100.000

TABLE 15.7-E FAUNAL LISTS BY COMPONENT SAN MARCOS

North Fork Sites

41WM73 - Areas A & E

Taxa	n	%
Cottontail Rabbit	1	7.14
Jackrabbit	1	7.14
Woodrat	1	7.14
White-tailed deer	1	7.14
Elements: medium	5	35.71
- large	3	21.42
Turtle sp.	1	7.14
Toad/Frog	1	7.14
Total	14	100.00

41WM56 - Area F

Taxa	n	%
Turtle sp.	1	100.00
Total	1	100.00

Granger Sites

41WM124 - Areas A & B

Taxa	n	%
Rabbit	4	4.00
Pocket Gopher	4	4.00
Deer Mouse	1	1.00
Cotton Rat	2	2.00
White-tailed deer	46	46.00
Cow/Bison	4	4.00
Elements: rodent	4	4.00
-small	2	2.00
-medium	1	1.00
-large	2	2.00
Snake sp.	2	2.00
Viper	5	5.00
Coluber	9	9.00
Turtle sp.	14	14.00
Total	100	100.00

41WM230 - XU 3

Taxa	n	%
Cottontail Rabbit	1	1.35
Pocket Gopher	4	5.40
Deer Mouse	1	1.35
Cotton Rat	3	4.05
Woodrat	1	1.35
Vole	1	1.35
White-tailed deer	12	16.21
Cow/Bison	1	1.35
Elements: rodent	9	12.16
-large	32	43.24
Coluber	3	4.05
Turtle sp.	2	2.70
Softshell Turtle	1	1.35
Toad/Frog	1	1.35
Fish sp.	2	2.70
Total	74	100.00

41WM163 - Area B

Taxa	n	%
White-tailed deer	6	85.71
Bison	1	14.29
Total	7	100.00

41WM267 - Areas A, B, D

Taxa	n	%
Cottontail Rabbit	42	2.88
Jackrabbit	19	1.30
Fox Squirrel	2	0.13
Ground Squirrel	11	0.75
Gocket Gnoher	195	13.40
Pocket Mouse	31	2.20
Beaver	1	0.06
Harvest Mouse	2	0.13
Deer Mouse	7	0.48
Pygmy Mouse	2	0.13
Cotton Rat	92	6.32
Woodrat	5	0.34
Vole	37	2.54
Dog/Coyote	10	0.68
Raccoon	3	0.20
Badger	3	0.20
cf. Mink	1	0.06
White-tailed deer	145	9.96
Pronghorn	2	0.13
Elements: rodent	343	23.57
-medium	36	2.47
-large	22	1.51
Prairie Chicken	2	0.13
Bobwhite	1	0.06
Perching Birds	3	0.20
Teal	1	0.06
Hawk	1	0.06
Bird-medium	8	0.55
Snake sp.	38	2.61
Viper	61	4.19
Coluber	219	15.05
Hog-nosed snake	2	0.13
Turtle sp.	37	2.54
Pond slider	2	0.13
Box Turtle	6	0.41
Lizard	27	1.85
Bullfrog	1	0.06
Toad/Frog	15	1.03
Salamander	4	0.27
Fish sp.	14	0.96
Crayfish	1	0.06
Total	1455	100.01

TABLE 15.7-F FAUNAL LISTS BY COMPONENT ROUND ROCK

North Fork Sites

41WM73 - Areas A,B,C,D,E

Taxa	n	%
Cottontail Rabbit	77	14.72
Jackrabbit	14	2.67
Fox Squirrel	1	0.19
Pocket Gopher	79	15.10
Pocket Mouse	1	0.19
Beaver	4	0.76
Cotton Rat	4	0.76
Woodrat	8	1.53
White-tailed Deer	31	5.92
Pronghorn	2	0.38
Cow/Bison	1	0.19
Elements: rodent	87	16.63
-Small	45	8.60
-Medium	20	3.82
-Large	2	0.38
Snake sp.	10	1.91
Viper	9	1.72
Coluber	14	2.67
Turtle sp.	80	15.29
Pond Slider	16	3.05
Toad/Frog	5	0.95
Fish sp.	7	1.33
Catfish	5	0.95
Bass/Sunfish	1	0.19
Totals	523	100.00

41WM56 - Areas B & C

Taxa	n	%
Least Shrew	1	0.25
Cottontail Rabbit	42	10.76
Jackrabbit	12	3.07
Fox Squirrel	2	0.51
Pocket Gopher	29	7.43
Cotton Rat	3	0.76
Woodrat	17	4.35
Dog/Coyote	1	0.25
White-tailed Deer	94	24.10
Pronghorn	7	1.79
Cow/Bison	3	0.76
Elements: rodent	47	12.05
-Small	16	4.10
-Medium	19	4.87
-Large	22	5.64
Bird-small	2	0.51
Snake sp.	9	2.30
Viper	3	0.76
Coluber	4	1.02
Turtle sp.	36	9.23
Pond Slider	5	1.28
Softshell Turtle	1	0.25
Lizard	1	0.25
Fish sp.	9	2.30
Gar	3	0.76
Catfish	2	0.51
Totals	390	100.00

41WM57 - Areas D & E

Taxa	n	%
Cottontail Rabbit	1	4.17
Jackrabbit	1	4.17
Woodrat	1	4.17
White-tailed Deer	17	70.83
Bison	2	8.32
Elements: medium	1	4.17
Turtle sp.	1	4.17
Totals	24	100.00

Granger Site

41WM230 - XU 3 & 9

Taxa	n	%
Opossum	1	2.77
Cottontail Rabbit	2	5.55
Pocket Gopher	5	13.88
Beaver	1	2.77
Cotton Rat	1	2.77
White-tailed Deer	9	25.00
Elements: rodent	12	33.33
-Large	2	5.55
Snake sp.	2	5.55
Coluber	1	2.77
Totals	36	100.00

41WM163 Area B

Taxa	n	%
Pocket Gopher	1	5.56
White-tailed Deer	15	83.32
Turtle sp.	1	5.56
Coluber	1	5.56
Totals	18	100.00

TABLE 15.7-G FAUNAL LISTS BY COMPONENT CLEAR FORK

North Fork Sites

41WM56 - Areas B,C,D,E

Taxa	n	%
Bat	1	0.1
Cottontail Rabbit	78	8.0
Jackrabbit	22	2.2
Fox Squirrel	1	0.1
Pocket Gopher	45	4.6
Pocket Mouse	2	0.2
Beaver	4	0.4
Cotton Rat	8	0.8
Woodrat	23	2.3
Dog/Coyote	6	0.6
Raccoon	1	0.1
Badger	1	0.1
White-tailed deer	162	16.7
Pronghorn	5	0.5
Cow/Bixon	4	0.4
Elements: rodent	73	7.5
-Small	49	4.6
-Medium	35	3.6
-Large	93	9.6
Turkey	1	0.1
Bird-medium	2	0.2
Snake sp.	27	2.7
Viper	17	1.7
Coluber	33	3.4
Turtle sp.	184	19.0
Pond Slider	2	0.2
Musk/Mud Turtle	5	0.5
Softshell Turtle	6	0.6
Bullfrog	1	0.1
Toad/Frog	6	0.6
Fish sp.	58	6.0
Gar	3	0.3
Catfish	8	0.8
Fresh water Drum	1	0.1
Shark sp.	1	0.1
Crayfish	1	0.1
Totals	969	100.0

41WM73 - Areas B & C

Taxa	n	%
Cottontail Rabbit	23	10.64
Jackrabbit	7	3.24
Fox Squirrel	1	0.46
Ground Squirrel	1	0.46
Pocket Gopher	26	12.03
Cotton Rat	4	1.85
Woodrat	3	1.38
Badger	1	0.46
White-tailed deer	9	4.16
Pronghorn	3	1.38
Elements: rodent	41	18.98
-Small	13	6.01
-Medium	8	3.70
-Large	1	0.46
Prairie chicken	1	0.46
Bird-medium	1	0.46
Snake sp.	3	1.38
Viper	2	0.92
Coluber	11	5.09
Turtle sp.	30	13.88
Pond Slider	5	2.31
Box Turtle	2	0.92
Musk/Mud Turtle	1	0.46
Softshell Turtle	2	0.92
Toad/Frog	8	3.70
Fish Sp.	7	3.24
Gar	1	0.46
Catfish	1	0.46
Totals	216	100.00

41WM57 - Area D

Taxa	n	%
Jackrabbit	3	17.64
Pocket Gopher	1	5.89
Cotton Rat	1	5.89
White-tailed Deer	5	29.41
Elements: rodent	1	5.89
-Medium	3	17.64
Turtle sp.	3	17.64
Totals	17	100.00

TABLE 15.7-G continued

Granger Sites

41WM124 - Area C

Taxa	n	%
Cottontail Rabbit	4	6.25
Jackrabbit	9	14.06
Beaver	2	3.12
Badger	1	1.56
White-tailed deer	26	40.62
Element: medium	1	1.56
Prairie Chicken	6	9.37
Bird-medium	2	3.12
Snake sp.	1	1.56
Viper	8	12.50
Coluber	2	3.12
Turtle sp.	1	1.56
Fish sp.	1	1.56
Total	64	100.00

41WM267 - Areas A, B, C

Taxa	n	%
Opossum	1	0.03
Least Shrew	2	0.06
Cottontail Rabbit	102	3.12
Jackrabbit	58	1.77
Ground Squirrel	15	0.46
Pocket Gpoher	166	5.08
Pocket Mouse	28	0.35
Beaver	1	0.03
Harvest Mouse	3	0.09
Deer Mouse	9	0.27
Grasshopper Mouse	2	0.06
Cotton Rat	239	7.32
Woodrat	10	0.30
Vole	12	0.36
Dog/Coyote	46	1.41
Raccoon	4	0.12
Badger	2	0.06
White-tailed deer	687	21.02
Proghorn	67	2.05
Elements: rodent	414	12.68
-small	19	0.58
-Medium	52	1.59
-Large	181	5.54
Prairie Chicken	10	0.30
Owl sp.	2	0.06
Duck	3	0.09
Lark Sparrow	2	0.06
Bird-small	2	0.06
Bird-medium	2	0.06
Bird-large	5	0.15
Snake sp.	143	4.38
Viper	261	7.99
Coluber	334	10.23
Water Snake	1	0.03
Hognose snake	6	0.18
Turtle sp.	134	4.10
Box Turtle	19	0.58
Pond Slider	18	0.55
Musk/Mud Turtle	10	0.30
Softshell Turtle	11	0.33
Lizard	54	1.65
Bullfrog	2	0.06
Toad/Frog	15	0.46
Salamander	2	0.06
Fish sp.	95	2.91
Gar	5	0.15
Catfish	7	0.21
Total	3263	99.99

TABLE 15.7-H FAUNAL LISTS BY COMPONENT SAN GERONIMO

North Fork

41WM56 - Areas A,C, & E

Taxa	n	%
Cottontail Rabbit	23	6.97
Jackrabbit	5	1.51
Pocket Gopher	23	6.97
Beaver	1	0.30
Woodrat	9	2.72
Dog/Coyote	3	0.90
White-tailed deer	58	17.57
Pronghorn	2	0.60
Elements: rodent	33	10.00
--Small	13	3.93
--Medium	10	3.03
--Large	20	6.06
Turkey	2	0.60
Snake sp.	17	5.15
Viper	9	2.72
Coluber	14	4.24
Turtle sp.	53	16.06
Fish sp.	30	9.09
Gar	2	0.60
Catfish	3	0.90
Totals	330	100.00

41WM57 - Area G

Taxa	n	%
Turtle sp.	1	50.00
Catfish	1	50.00
Totals	2	100.00

Granger

41WM267 - Areas A, B, & D

Taxa	n	%
Opossum	3	0.32
Rabbit	77	8.30
Jackrabbit	44	4.74
Fox Squirrel	2	0.21
Pocket Gopher	28	3.02
Pocket Mouse	10	1.07
Deer Mouse	4	0.43
Grasshopper Mouse	1	0.10
Harvest Mouse	7	0.75
Cotton Rat	94	10.14
Woodrat	26	2.80
Vole	1	0.10
Dog sp.	37	3.99
Coyote	5	0.54
Raccoon	3	0.32
Skunk	1	0.10
Bobcat	1	0.10
cf. Puma	1	0.10
Deer	91	9.81
Pronghorn	27	2.91
Bison	15	1.61
Elements: rodent	113	12.19
--Small	5	0.54
--Medium	14	1.51
--Large	47	5.07
Bird sp.	5	0.54
Teal	1	0.10
Bobwhite	1	0.10
Turkey	1	0.10
Prairie Chicken	6	0.64
Owl	1	0.10
Robin	1	0.10
Snake sp.	35	3.77
Viper	57	6.14
Coluber	56	6.04
Hog-nosed Snake	1	0.10
Rat Snake	1	0.10
Turtle sp.	58	6.25
Box Turtle	10	1.07
Pond Slider	6	0.64
Musk/Mud Turtle	2	0.21
Soft-shell Turtle	2	0.21
Lizard sp.	3	0.32
Toad/Frog sp.	4	0.43
Bullfrog	2	0.21
Fish sp.	10	1.07
Gar	4	0.43
Catfish	1	0.10
Bass/Perch	2	0.21
Totals	927	100.01

TABLE 15.7-I FAUNAL LISTS BY COMPONENT MIXED

North Fork Sites Only

Austin/Twin Sisters
41WM53 - Areas A & B

Taxa	n	%
Cottontail Rabbit	3	6.38
Raccoon	2	4.25
White-tailed deer	31	65.95
Elements: rodent	3	6.38
-Large	1	2.12
Viper	1	2.12
Coluber	1	2.12
Turtle sp.	5	10.63
Totals	47	100.00

Round Rock/Clear Fork
41WM73 - Area B

Taxa	n	%
Cottontail Rabbit	117	13.47
Jackrabbit	32	3.68
Fox Squirrel	3	0.34
Pocket Gopher	143	16.47
Beaver	5	0.57
Deer Mouse	1	0.11
Pygmy Mouse	1	0.11
Cotton Rat	16	1.84
Woodrat	9	1.03
Dog/Coyote	6	0.69
Raccoon	4	0.46
Badger	5	0.57
Skunk sp.	1	0.11
White-tailed deer	42	4.83
Pronghorn	1	0.11
Elements: rodent	134	15.43
-Small	42	4.83
-Medium	21	2.41
-Large	2	0.23
Bobwhite	1	0.11
Perching Birds	1	0.11
Hawk	1	0.11
Bird-medium	1	0.11
Bird-large	1	0.11
Snake sp.	11	1.26
Viper	12	1.38
Coluber	16	1.84
Turtle sp.	132	15.20
Pond Slider	39	4.49
Box Turtle	2	0.23
Musk/Mud Turtle	3	0.34
Bullfrog	5	0.57
Toad. Frog	20	2.30
Fish sp.	28	3.22
Gar	1	0.11
Catfish	9	1.03
Totals	868	100.00

San Marcos/Round Rock
41WM56 - Areas A & D

Taxa	n	%
Cottontail Rabbit	21	11.41
Jackrabbit	8	4.34
Pocket Gopher	12	6.52
Cotton Rat	4	2.17
Woodrat	6	3.26
Dog/Coyote	4	2.17
White-tailed deer	66	35.87
Cow/Bison	1	0.54
Elements: rodent	19	10.32
-Medium	11	5.97
-Large	3	1.63
Snake sp.	1	0.54
Viper	2	1.08
Coluber	7	3.80
Turtle sp.	12	6.52
Pond Slider	2	1.08
Toad/Frog	1	0.54
Fish sp.	3	1.63
Gar	1	0.54
Totals	184	100.00

Round Rock/Clear Fork
41WM56 - Area B

Taxa	n	%
Cottontail Rabbit	4	6.78
Jackrabbit	3	5.08
Fox Squirrel	1	1.69
Pocket Gopher	1	1.69
Woodrat	2	3.39
White-tailed deer	17	28.81
Pronghorn	1	1.69
Cow/Bison	1	1.69
Elements: rodent	3	5.08
-Small	1	1.69
-Medium	3	5.08
-Large	9	15.25
Snake sp.	1	1.69
Viper	1	1.69
Turtle sp.	9	15.25
Fish sp.	2	3.39
Totals	59	100.00

San Marcos/Round Rock
41WM57 - Areas A,B,C,F,G,H,I

Taxa	n	%
Cottontail Rabbit	1	2.22
Pocket Gopher	1	2.22
Dog/Coyote	1	2.22
White-tailed Deer	33	73.33
Bison	3	6.67
Elements: small	2	4.45
-Medium	1	2.22
Turtle sp.	2	4.45
Viper	1	2.22
Totals	45	100.00

Vertebrate Faunal Remains from North Fork Reservoir Excavations

Seven of the thirteen sites excavated at the proposed North Fork reservoir yielded bone. A total of 50,804 pieces of bone was recovered and 13% of these are identifiable to some degree. Over 3/4 of the identifiable material is attributable to mammals, with deer, rabbit, and rodents constituting the bulk of that 75%. Reptiles rank second with 19%, but most of this material is fragmentary turtle shell and snake vertebrae; therefore, the actual amount of meat provided by these animals is disproportionate to their ranking. Fish rank next at 3.5% and may also be disproportionate in the opposite manner; that is, the food energy available from fish is greater than that from an equal weight of reptile meat, and fish are generally under-represented in archaeological samples because of poor preservation and screening techniques (especially recovery of remains from small fish like shad) (Limp and Reidhead, 1979). Amphibians are next at 1.1% and birds at .2%; these low percentages probably reflect the delicate nature of the bones of these taxa and the difficulty in identifying them in a fragmentary state. Nonmolluscan invertebrates are represented by the presence of a burned crayfish claw from 41WM56.

Each site will be discussed in this section of the analysis with an emphasis on the various excavation areas and their cultural components. Unit totals recorded by excavated levels and complete species list for each unit from each site are provided in Appendix C. The summary tables for each site description give pertinent information for complete components or important transitions only. Mixed components or levels without diagnostics are not charted in these tables nor are data from backhoe trenches or plow zone levels. Features are discussed at the end of each site report.

Site 41WM53

Three major excavation areas were opened at this site to an overall depth of approximately 90 cm. Bone was removed from 17.85 m^3, not including backhoe material. A total of 2,092 pieces of bone were recovered from this volume and 45 fragments were taken from the backhoe fill. Four percent (15 pieces) are identifiable to some degree and 39% of the total bone is burned. See species lists, Table 15.7-3. Poor preservation accounts for the high percentage of unidentifiable faunal remains (Appendix C). The osseous material appears to have been water worn, pitted, and etched by vegetation. Fragment size is primarily large animal bone splinters of which 61% are unburned. According to Schmid (1972), Leechman (1968) and Vehik (1977), this quantity of unburned long bone fragments is consistent with bone grease manufacturing. The presence of formal hearths and much burned rock further suggests the occurrence of this activity.

Table 15.7-3. Total Number of Elements by Vertical Provenience, Site 41WM53

AREA A

	AUSTIN					AUSTIN/TWIN SISTERS					TWIN SISTERS				
SPECIES Lv.	1 & 2	(T)	(B)	MNI	2.2m³	3 & 4	(T)	(B)	MNI	2.0m³	5+	(T)	(B)	MNI	4.3m³
Rabbit						3	(3)	-	1	1.50					
Fox Squirrel	1	-	-	1	.45										
Pocket Mouse	1	(1)	-	1	.45										
Raccoon						2	(1)	-	1	.10					
Rodent						3	-	-		1.50					
Small mam.	1	-	-	1	.45										
Large mam.											1	-	-	1	.23
Deer	12	(4)	(3)	1	5.45	28	(7)	(7)	1	14.00	3	(1)	(1)	1	.69
Viper						1				.50					
Colubrid						1				.50					
Turtle sp.	2	-	(1)		.90	5		(1)		2.50					
Fish	1	-	-		.45										

AREA B

	AUSTIN				AUSTIN/TWIN SISTERS					TWIN SISTERS				
SPECIES Lv.	4 - 5	(T)	(B)	MNI	6 - 7	(T)	(B)	MNI	1.4m³	8 - 9	(T)	(B)	MNI	4.0m³
Large	1	-	-		-	-	-		.71	1	-	(1)	1	.25
Deer	15	(4)	2	1	3	-	(1)	1	2.14	10	(3)	(1)	1	2.50
Turtle sp.					1		(1)			1	-	(1)		.25

AREA C

	UNKNOWN					TWIN SISTERS				
SPECIES Lv.	1 & 2	(T)	(B)	MNI		3+	(T)	(B)	MNI	3.1m³
Rodent	1	(1)	-	1						
Deer						1	-	-	1	.32

The following table (Table 15.7-4) summarizes pertinent faunal information for the site as a whole. The three cultural components are given as the major vertical divisions, and the excavation areas (horizontal provenience) that contain those components are listed with the vertical provenience in arbitrary level indicators for convenience. The descriptive statistics that follow provide intercultural comparisions for total numbers of osteological fragments recovered from levels designated as a certain component. The density of total bone is calculated by dividing the total bone by the combined volumes of matrix excavated from the designated levels. The number of identified elements (#ID) are included in the Total, and percentage identifiable (%ID) is calculated by dividing the #ID by the Total.

TABLE 15.7-4 Faunal Summary for 41WM53

COMPONENT	AUSTIN	AUSTIN/TWIN SISTERS	TWIN SISTERS
AREA	A Lv. 1-2 B Lv. 4-5	A Lv. 3-4 B Lv. 6-7	A Lv. 5-9 B Lv. 8-9 C Lv. 3-9
Vol. m^3	2	3.4	11.4
TOTAL BONE	559	1034	494
DENSITY/m^3	279	304	43
# ID	21	47	17
% ID	4	4.5	3
MAMMALS	*85.7%*	*85%*	*94%*
BIRDS	-	-	-
REPTILES	*9.5%*	*15%*	*6%*
AMPHIBIANS	-	-	-
FISHES	*4.7%*	-	-
TOTAL % BURNED	37	39	44
ID % BURNED	29	25	19

Like the other North Fork sites, 41WM53 fauna consists mainly of mammalian remains throughout the occupations with deer and large mammal (probably deer) providing most of the meat. Fish and reptile remains consist of vertebrae and turtle carapace fragments only.

As the preceding table indicates, this site contains late occupation remains with Austin focus material in the upper levels of areas A and B and Twin Sisters material in the lower levels of all three areas. The transitional sequence in the mid levels yielded almost twice as much bone as either of the "pure" zones and a slightly higher percentage of identifiable remains. The reason for this is unclear.

All 3 excavation areas are approximately 60 meters south of the river and 90 meters north of the bluff's edge (Fig.8.1-1). The tree gallery along the river would have provided a suitable zone of utilization for all of the species identified from this site.

Twin Sisters

Fauna from this component is limited to deer and one burned turtle shell fragment (Table 15.7-D). The category of large mammal is used for identifiable elements from large animals when species determination is uncertain due to fragmentation or deterioration. The two elements in question from these levels are probably deer also.

Excavation unit B yielded most of the deer remains. The bones are in very poor condition and 3 fragments are burned: 2 antler fragments (1 from Area A) and a metatarsal fragment. These burned bones are burned white indicating long exposure to a very hot fire. A left mandible fragment with 2 extremely worn molars indicates an old adult approximately 8 or 9 years old.

Regarding the deer mandibles from this site, each specimen recovered had been broken in a similar manner. (A left mandible fragment from another individual was recovered from the backhoe material.) The basal border of each is broken away exposing the roots of the intact teeth. The specimen from the BHT is charred along the basal break. Gilbert (1973) cites evidence that bones break easier when the periostial sheath is removed either by scraping or by burning. He further notes that the marrow cavity located below the tooth roots in mandibles is exposed by "delivering blows with the blunt end of an axe to the inferior border of the mandible while it is supported on an anvil stone" (1973: 10). The three examples from 41WM53 fit this description and associate this technique with the Twin Sisters occupation.

Austin/Twin Sisters

Species diversity is greater in this transitional zone. Rabbit, raccoon and snakes are represented in these levels but are absent in the upper levels. Rabbit remains are exclusively loose teeth, no post-cranial remains. A complete right mandible from an old raccoon (as indicated by extreme wear on the molars) comes from level 3; it is badly weathered and shows no indications of burning. Two snake vertebrae indicate the presence of at least one poisonous and one non-poisonous snake, both from Area A. One of five turtle shell fragments is burned (Table 15.7-I).

More deer remains are found in this component than in the upper or very lowest components. Only one individual is indicated and most of the body parts are present. Burned elements consist of one antler fragment, metatarsal fragments and phalanges, although evidence of charring exists on a proximal right radius and right ulnar notch as well as on a femur fragment. An unburned antler tip comes from Area A level 4 and the burned antler fragment is from Area B level 4. Butchering marks are not visible due to the eroded bone surfaces. However, all of the long bone fragments show evidence of spiral fracturing. A right mandible fragment, with all teeth intact except the third molar, suggests a deer about 4 years old at time of death. All aging is based on occlusal attrition according to Severinghaus (1949).

Austin

The deer remains from all three excavation units consist only of burned antler fragments, lower leg and feet bones (two slightly burned) and two vertebral fragments. One of the vertebral fragments is burned and is from an immatrue individual; the other is from a fully mature adult.

As the species list in Table 15.7-B shows, only four non-deer fragments were identifiable mammals (squirrel, pocket mouse and two other rodent/ small mammal elements). The non-mammals are represented by some turtle shell (with one burned fragment) and one fish vertebra from a species no larger than bluegill or gizzard shad.

Features

The only feature in Area A containing bone is F-6 consisting of three deer elements: a burned tibia fragment, a tooth fragment, and a sesamoid bone all from level 5. No butchering marks are visible.

Bone recovered from features in Area B consists of an astragulus from a small deer (female?) and a tooth enamel fragment probably from the same deer both of which were recovered from F-4 level 5. Another deer tooth fragment was recovered from F-8. Non of the feature bones from Area B is

burned nor shows evidence of butchering. These features are described in detail elsewhere as well as discussion of modified bone.

Site 41WM56

The Hawes Site has six areas of excavation where the overall depths range from 70 to 170 cm. A total of 31,663 bone fragments were removed from approximately 41.1 m^3, excluding backhoe material. More bone was recovered from this site than from any other in the project. This terrace site spans five cultural periods with some cultural components mixed and transitory. Each unit has at least three components and most have four or five (Table 15.7-5).

From all excavation units, deer is the species with the greatest density which is at highest frequency at Area B (Round Rock phase) and next highest in the Round Rock/Clear Fork transition at the same excavation unit. The San Marocs/Round Rock transition at Area A ranks third in deer density. Species diversity is least at Area F, the smallest unit excavated (Tables 15.7-6 through 15.7-12).

Species diversity is greatest at Area C, which may be attributable to the greater size of the excavation unit itself in comparison with other areas.

The following table outlines the major cultural components, including transitions, and where they are found at the site. Plow zones, mixed levels, and levels of indeterminable association are not included.

As this table indicates, mammals are the most abundant vertebrate class followed by reptiles, then fish. This pattern holds true for all North Fork sites. Deer occurs most frequently in all components except the San Marcos component and the Clear Fork component where fragmentary turtle shell outnumbers identifiable deer elements only slightly. More bones are identifiable in the earlier phases even though preservation remains consistently poor throughout. The condition of the unidentifiable sample is quite similar to 41WM53, although not so badly pitted. The fragments are mostly long bone splinters from large mammals except in Area A where they are broken into smaller fragments. The percentage of total burned bones is greatest during the Twin Sisters and Clear Fork components while percentage of burned bone in the identifiable sample is greatest during the Round Rock/Clear Fork transition and lowest in the San Geronimo phase, disregarding the small identifiable sample from the San Marcos phase.

San Geronimo

The lower levels of units A, C, and E yielded 2,744 bone fragments of which 330 are identifiable at least to vertebrate class. No bone was recovered from Area D for this phase. Amphibians are the only vertebrates

TABLE 15.7-5 Faunal Summary for 41WM56

COMPONENT	TWIN SISTERS	SAN MARCOS	SAN MARCOS/ ROUND ROCK	ROUND ROCK	ROUND ROCK/ CLEAR FORK	CLEAR FORK	SAN GERONIMO
AREAS	A Lv. 1-3 F Lv. 1-3	F Lv. 6-7	A Lv. 4 D Lv. 4-6	B Lv. 4-5 C Lv. 5	B Lv. 6-7	B Lv. 8-13 C Lv. 6-9 D Lv. 8-9 E Lv. 4-6	A Lv. 5-9 C Lv. 10-17 D Lv. 10-12 E Lv. 7-10
Vol. m^3	3.6	.7	1.8	2.8	.8	12.1	11.5
TOTAL BONE	1126	50	1647	3044	476	7825	2744
DENSITY/m^3	312	71	915	1087	595	646	238
# ID	73	1	184	390	59	969	330
% ID	6.5	2.0	11.0	12.8	12.0	12.0	12.0
MAMMALS	*85.0%*		*84.2%*	*80.8%*	*78.0%*	*63.3%*	*60.6%*
BIRDS	-	-	-	*.5%*	-	*.3%*	*.6%*
REPTILES	*9.6%*	*100.0%*	*13.0%*	*15.1%*	*18.6%*	*28.3%*	*28.2%*
AMPHIBIANS	-	-	*.5%*	-	-	*.7%*	-
FISHES	*5.5%*	-	*2.1%*	*3.6%*	*3.4%*	*7.3%*	*10.6%*
TOTAL % BURNED	32.0	22.0	19.0	28.0	24.7	32.0	30.0
ID % BURNED	18.0	0.0	7.6	17.0	8.5	19.0	2.6

Table 15.7-6. Total Number of Elements by Vertical Provenience, Site 41WM56

AREA A

	TWIN SISTERS					SAN MARCOS/ROUND ROCK					SAN GERONIMO				
SPECIES Lv.	1 - 3	(T)	(B)	MNI	1.8m³	4	(T)	(B)	MNI	.6m³	5 - 9	(T)	(B)	MNI	2.5m³
Rabbit	3	(2)	-	1	1.66	2	(2)		1	3.3	12	(10)	(1)	1	4.3
Jackrabbit						1	-	-	1	1.6	2	(2)	-	1	.8
Pocket Gopher						1	-	-	1	1.6	7	(5)	-	1	2.8
Beaver											1	(1)	-	1	.4
Woodrat						1	(1)	-	1	1.6	5	(4)	(1)	1	2.0
Rodent											6	(4)	-		2.4
Small	4	(1)	-		2.22						4	(2)	-		1.6
Medium mam.	1	(1)	-		.55	1	(1)	-		1.6	1	(1)	-		.4
Large mam.						2	(2)	-		3.3	1	(1)	-		.4
Dog sp.	2	(2)	(1)	1	1.11	3	(3)	(1)	1	5.0	2	(1)	-	1	.8
Deer	17	(4)	(7)	1	9.44	26	(7)	(5)	1	43.3	25	(10)	(6)	1	10.0
Turkey											1	-	(1)		.4
Turtle sp.	2	-	(1)		1.11	2	-	-		3.3	3	-	-		1.2
Pond Slider						1	-	-		6.6					
Viper											2	-	-		.8
Fish sp.	1				.55						2	-	(1)		.8
TOTAL ID	30					40					74				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

Table 15.7-7. Total Number of Elements by Vertical Provenience, Site 41WM56

AREA B

SPECIES	UNKNOWN				MIXED SAN MARCOS				ROUND ROCK					ROUND ROCK/CLEAR FORK					CLEAR FORK				
	Lv.1-2	(T)	(B)	MNI	3	(T)	(B)	MNI	4-5	(T)	(B)	MNI	.8m³	6-7	(T)	(B)	MNI	.4m³	8-13	(T)	(B)	MNI	1.5m³
Armadillo	2	-	-	1																			
Least Shrew									1	-	-	1	1.25										
Rabbit	3	(2)	-	1	5	(3)	-	1	15	(9)	-	1	18.75	4	(2)	-	1	10.00	3	(3)	-	1	2.00
Jackrabbit									3	(3)	-	1	3.75	3	-	-	1	7.50					
Fox Squirrel									1	-	-	1	1.25	1	(1)	-	1	2.50					
Pocket Gopher					1	-	-	1	9	(6)	-	1	11.25	1	(1)	-	1	2.50	3	(3)	-	1	2.00
Pocket Mouse	1	-	-	1																			
Cotton Rat									1	-	(1)	1	1.25										
Woodrat					1	-	-	1	3	-	-	1	3.75	2	(1)	-	1	5.00					
Dog sp.									1	-	(1)	1	1.25										
cf. Pronghorn	1	(1)	-	1	2	(2)	-	1	4	(3)	-	1	5.00	1	1	(1)	1	2.50	2	(2)	-	1	1.33
Deer	33	(7)	(7)	1	43	(19)	(8)	1	44	(19)	(6)	2	55.00	17	(8)	(1)	1	42.50	13	(3)	-	1	8.66
Cow/Bison					2	-	-	1	2	(1)	-	1	2.50	1	-	-	1	2.50					
Rodent					2	-	-		10	(4)	(1)		12.50	3	(2)	-		7.50					
Smallmam.					1	-	-		4	-	-		5.00	1	-	-		2.50	2	-	(1)		1.33
Medium mam.	1	(1)	(1)						7	(3)	(2)		8.75	3	(1)	(2)		7.50	3	(1)	(2)		2.00
Large mam.	1	(1)	-		11	(11)	(1)		3	(3)	-		3.75	9	(9)	-		22.50	2	(2)	-		1.33
Turtle sp.	2	-	-		1	-	(1)		12	-	(2)		15.00	9	-	(1)		22.50					
Softshell Turtle									1	-	-		1.25						1	-	(1)		.66
Pond Slider	1	-	(1)						2	-	(1)		2.50										
Snake sp.					1	-	-		3	-	-		3.75	1	-	-		2.50					
Viper					2	-	-		1	-	(1)		1.25	1	-	-		2.50	1	-	-		.66
Colubrid	1	-	-																				
Fish sp.									1	-	-		1.25	2	-	-		5.00					
Gar									2	-	-		2.50										
TOTAL ID	46				72				130					59					30				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

Table 15.7-8. Total Number of Elements by Vertical Provenience, Site 41WM56

AREA C

SPECIES	UNKNOWN				ROUND ROCK					CLEAR FORK					SAN GERONIMO				
Lv.	1 - 4	(T)	(B)	MNI	5	(T)	(B)	MNI	2.0m³	6 - 9	(T)	(B)	MNI	8.0m³	10-17	(T)	(B)	MNI	6.7m³
Bat sp.										1				1.25					
Rabbit	90	(56)	(13)	5	27	(17)	(5)	1	13.50	63	(29)	(11)	6	7.87	7	(3)	(4)	1	1.04
Jackrabbit	20	(13)	(3)	2	9	(2)	(4)	3	4.50	18	(7)	(5)	1	2.25	2	-	(1)	1	.29
Fox Squirrel	5	(3)	(1)		1	(1)	-	1	.50	1	(1)	-	1	.12					
Pocket Gopher	41	(20)	(4)	3	20	(17)	(2)	1	10.00	31	(21)	(1)	2	3.87	4	(2)	-	1	.59
Pocket Mouse	7	(2)	-	1						2	-	-	1	.25					
Beaver	1	(1)	-	1						4	(3)	(1)	1	.50					
Cottonrat	10	(5)	(1)	1	2	-	-	1	1.00	7	(3)	(1)	1	.87					
Woodrat	22	(11)	(1)	1	14	(12)	(1)	1	7.00	20	(13)	-	1	2.50	3	(1)	(2)	1	.44
Vole	2	(2)		1															
Rodents	95	(27)	(13)		37	(21)	(9)		18.50	60	(42)	(10)		7.50	17	(14)	-		2.53
Small mam.	53	-	(13)		12	(1)	(4)		6.00	34	-	(10)		4.25	6	-	(1)		.89
Medium mam.	30	(18)	(10)		12	(5)	(4)		6.00	29	(24)	(19)		3.62	7	(3)	(3)		1.04
Large mam.	123	(119)	(8)		19	(19)	-		9.50	79	(76)	(3)		9.87	11	(11)	-		1.64
Dog sp.	5	(4)	-	1						5	(4)	-	1	.62	1	(1)	-		.14
Raccoon	4	(4)	(1)	1						1	(1)	-		.12					
Badger										1	-	-		.12					
Deer	465	(148)	(129)	4	50	(17)	(12)	2	25.00	113	(35)	(37)	2	14.12	14	(1)	(6)	1	2.09
cf. Pronghorn	4	-	(2)	1	3	(2)	-	1	1.50	1	-	-	1	.12					
Cow/Bison	6	(2)	-		1	-	(1)	1	.50										
Bird sp.	2	-	-		2	-	-		1.00										
Turkey	2	-	-																
Snake sp.	13	-	(3)		6	-	(1)		3.00	27	-	(8)		3.37	10	-	(5)		1.49
Viper	7	-	-		2	-	(1)		1.00	14	-	(4)		1.75	3	-			.44
Colubrid	20	-	-		4	-	(1)		2.00	32	-	(6)		4.00	6	-	(2)		.89
Hog-nosed Snake	1	-	-																
Turtle sp.	101	-	(23)		24	-	(5)		12.00	164	-	(22)		20.50	17	-	(6)		2.53
Mud/Musk Turtle	1	-	-							5	-	(2)		.62					
Pond Slider	7	-	(2)		3	-	-		1.50	2	-	-		.25					
Softshell Turtle	3	-	(1)							3	-	(1)		.37					

Table 15.7-8. Total Number of Elements By Vertical Provenience

AREA C, continued

SPECIES Lv.	UNKNOWN				ROUND ROCK					CLEAR FORK					SAN GERONIMO				
	1 - 4	(T)	(B)	MNI	5	(T)	(B)	MNI	2.0m³	6 - 9	(T)	(B)	MNI	8.0m³	10-17	(T)	(B)	MNI	6.7m³
Lizard sp.	3	-	-		1	-	-		.50										
Frog sp.	6	-	(1)							7	-	(2)		.87					
Bullfrog	1	-	-																
Fish sp.	39	-	(3)		8	-	(1)		4.00	50	-	(3)		6.25	23	-	(2)		3.43
Gar	6	-	-		1	-	(1)		.50	3	-	(1)		.37	2	-	-		.29
Catfish	6	-	(3)		2	-	(1)		1.00	8	-	(5)		1.00	2	-	-		.29
Drum										1	-	-		.12					
Shark										1	(1)	-		.12					
Crayfish										1	-	(1)		.12					
TOTAL ID	1201				260					788					135				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

Table 15.7-9. Total Number of Elements by Vertical Provenience, Site 41WM56

Area C, Upper Levels only

n=number of elements d=density per cubic meter

SPECIES	Level 1 2.0 m^3		Level 2 2.0 m^3		Level 3 2.0 m^3		Level 4 2.0 m^3	
	n	d	n	d	n	d	n	d
Rabbit			21	105	35	17.5	23	11.5
Jackrabbit			3	1.5	6	3	9	4.5
Fox Squirrel			2	1	1	.5	1	.5
Pocket Gopher								
Pocket Mouse					5	2.5		
Beaver							1	.5
Cotton Rat			6	3	1	.5	2	1
Woodrat			4	2	9	4.5	6	3
Vole			1	.5	1	.5		
Dog sp.			2	1	2	1	1	.5
Raccoon			2	1	1	.5	1	.5
Badger					1	.5		
Deer	24	12	121	61	207	103.5	114	57
Pronghorn	2	1					2	1
Cow/Bison			1	.5	3	1.5	2	1
Mammal elements	3	1.5	57	28.5	92	46	18	9
Bird sp.			1	.5	3	1.5		
Snake sp.			4	2	3	1.5	1	.5
Viper			2	1	2	1	6	3
Colubrid			4	2	10	5	4	2
Hog-nosed Snake			1	.5				
Turtle sp.	2	1	18	9	33	165	42	21
Pond Slider					4	2	3	1.5
Mask/Mud Turtle							1	.5
Soft Shell Turtle			2	1	1	.5		
Lizard sp.							1	.5
Frog sp.			1	.5	2	1	4	2
Fish			11	5.5	19	9.5	8	4
Gar			1	.5			3	1.5
Catfish			2	1	1	.5	1	.5

Table 15.7-10. Total Number of Elements by Vertical Proveniences, Site 41WM56

AREA D

SPECIES	MIXED ZONE				ROUND ROCK/SAN MARCOS					UNKNOWN				CLEAR FORK				
Lv.	1 - 3	(T)	(B)	MNI	4 - 6	(T)	(B)	MNI	$1.2m^3$	7	(T)	(B)	MNI	8 - 9	(T)	(B)	MNI	$.8m^3$
Rabbit	6	(4)	(2)	1	19	(8)	(2)	1	15.83	3	(3)	-	1	4	(2)	-	1	5.00
Jackrabbit	1	-	-	1	7	(4)	(1)	1	5.83									
Pocket Gopher					11	(7)	(1)	2	9.16					3	(1)	-	1	3.75
Pocket Mouse	1	-	-	1						3	(1)	-	2					
Cotton Rat					4	-	-	1	3.33					1	-	-	1	1.25
Woodrat	3	-	(3)	1	5	(5)	-	1	4.16	1	-	(1)	1	1	(1)		1	1.25
Rodent	9	(3)	(1)		19	(9)	-		15.83	4	-	-		1	-	-		1.25
Small mam.																		
Medium mam.	1	-	-		10	(6)	-		8.33					1	-	-		1.25
Large mam.	3	-	-		1	-	-		.33					1	(1)			1.25
Dog sp.	5	(5)	-	1	1	(1)	-	1	.83	1	(1)	-	1					
Deer	36	(14)	(4)	1	40	(21)	(3)	1	33.33	6	(1)	-	1	5	(5)	-	1	6.25
cf. Pronghorn	1	(1)	-															
Cow/Bison	1	(1)	-		1	(1)	-		.83					2	(1)	(1)		2.50
Bobwhite										1	-	(1)						
Perching Bird sp.	2	-	-															
Turtle sp.	5	-	(1)		10	-	(1)		8.33					6	-	-		7.50
Pond Slider					1	-	-		.83	1	-	-						
Softshell Turtle	1	-	-															
Snake sp.	3	-	-		1	-	-		.83	1	-	-						
Colubrid	9	-	(1)		7	-	-		5.83	2	-	(2)						
Viper	3	-	-		2	-	-		1.66	1	-	-						
Frog sp.	3	-	-		1	-	-		2.50					5	-	-		6.25
Gar					1	-	-		.83									
Fish Sp.	3	-	-		3	-	-			3	-	-						
TOTAL ID	96				144					27				30				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

Table 15.7-11. *Total Number of Elements by Vertical Provenience, Site 41WM56*

AREA E

SPECIES Lv.	MIXED ZONE 1 - 2	(T)	(B)	MNI	ROUND ROCK 3	(T)	(B)	MNI	CLEAR FORK 4 - 6	(T)	(B)	MNI	$1.8m^3$	SAN GERONIMO 7 -10	(T)	(B)	MNI	$1.3m^3$
Rabbit	2	(1)	-	1	1	(1)	-	1	3	(6)	(5)	1	4.44	4	(1)	-	1	3.07
Jackrabbit					2	-	(1)	1	4	(2)	(2)	1	2.22	1	-	-	1	.76
Fox Squirrel	1	-	-	1														
Pocket Gopher	1			1	2	(1)	(1)	1	8	(4)	-		4.44	12	(10)	-	1	9.23
Woodrat									2	(2)	-	1	1.11	1	(1)	-	1	.76
Raccoon					1	(1)	-	1										
Dog sp.									1	-	-	1	.55					
Pronghorn	1	(1)	-	1					2	(2)	-	1	1.11	2	(1)	-	1	1.53
Deer	16	(7)	(4)	1	12	(1)	(2)	1	31	(8)	(3)	1	17.22	19	(3)	(1)	1	14.61
Cow/Bison									2	-	-	1	1.11					
Rodent	3	(2)	-		2	(1)	-		12	(5)	(1)		6.66	10	(3)	(1)		7.69
Small mam.	2	-	(1)						13	-	(1)		7.22	3	-	(1)		2.30
Medium mam.	1	(1)	(1)						2	(1)	(1)		1.11	2	(2)	-		1.53
Large mam.	1	(1)	(1)		3	(3)	-		11	(9)	(5)		6.11	8	(8)	-		6.15
Bird sp.									2	-	(1)		1.11					
Turkey	1	-	(1)						1				.55	1	-	-		.76
Turtle sp.	4	-	(1)		3	-	(1)		14	-	(6)		7.77	33	-	(3)		25.38
Softshell Turtle									2	-	(1)		1.11					
Snake sp.	1	-	(1)											7	-	(1)		5.38
Viper									2	-	(1)		1.11	4	-	(2)		3.07
Colubrid									1	-	-		.55	8	-	(2)		6.15
Fish sp.					1	-	-		3	-	-		1.66	5	-	-		3.84
Catfish														1	-	-		.76
Human					1	-	-											
TOTAL ID	34				28				121					121				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

Table 15.7-12. Total Number of Elements by Vertical Provenience, Site 41WM56

AREA F

	TWIN SISTERS					UNKNOWN				SAN MARCOS				
SPECIES Lv.	1 - 3	(T)	(B)	MNI	1.8m³	4 - 5	(T)	(B)	MNI	6 - 7	(T)	(B)	MNI	.7m³
Rabbit						1	(1)	-	1					
Pocket Gopher	1	(1)	-	1	.55									
Large mam.	19	(19)	(1)		10.55									
Deer	10	(1)	(1)	1	5.55	4	-	-	1					
Cow/Bison	5	(5)	-	1	2.77					1	-	-		1.429
Turtle sp.	5	-	(4)		2.77									
Catfish	3	-	(3)		1.66									
TOTAL ID	43					5				1				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

not represented in the recovered material, but fish are well represented comprising 10% (of 330) of the identified sample. Frequency of fish is highest in this cultural phase than in any other as indicated in the preceding table. Small varieties of both gar and catfish are identified as well as other small fish of which three vertebrae are burned.

Like the fish remains, bird elements are found in highest frequency in this zone as compared to the other components, although only two turkey bones were identified, one of which is burned. No butchering cuts are visible. However, the spur on the larger element, a right tarsometatarsus from Area E may, have been chopped as suggested by two irregular notched areas on the shaft above the spur.

Reptile remains consist of 53 fragments of turtle shell of which only nine are burned. Species of turtle is indeterminable, although most are probably aquatic. Area E and C had small concentrations of turtle shell fragments, and minimum number of individuals cannot be determined. Both poisonous and non-poisonous snake remains come from Areas C and E, and 32% of these are burned suggesting utilization of snakes as a food item. Some snake vertebrae were probably consumed along with the meat as this is easier than removing the bones. Therefore, while turtle is over-represented in the sample due to the fragmentary nature of the shells, snakes are probably under-represented due to consumption of the whole animal.

Mammal remains comprise slightly more than half of the identifiable fauna but is lowest in percentage when compared with the other cultural components (excluding the San Marcos levels). Deer, of course, is most frequently identified, constituting 17% of the identified material from this phase. Only one deer is apparent in each of the excavation areas for this component, but these elements may all be from the same deer. A fragment of antler with the burr intact was recovered from Area A. Since the burr is present without traces of the pedicle, seasonality assessment is difficult. However, Ryder (1968) states that a burr fragment found in a prehistoric site may have been collected shortly after shedding, which in white-tailed deer occurs in February or March (Gilbert, 1973). Very few deer elements are burned, only some antler fragments in Area A and E and a phalange fragment in Area A, as well as six others in Area E. No butchering marks are evident.

Other mammals recovered from this component are listed in Table 15.7-H. No bison was identified. However, a tooth fragment and a hoof phalange identified as pronghorn antelope were recovered from Area E. Smaller mammals, such as cottontail rabbit and pocket gopher, are present in moderate quantities of elements, although most of the elements are loose teeth (Tables 15.7-6,8,11). Beaver is indicated by a single unburned molar from Area A. Canid remains are entirely dental except for a shaft fragment from a left tibia, unburned and badly pitted. The canid teeth are also in poor condition prohibiting exact species determination. Jackrabbit is poorly represented with only five fragmentary elements.

The San Geronimo Phase at 41WM56 is dominated by aquatic and forest faunas. The few prairie species found in the levels assigned to this component are scant in elements and may actually be intrusive from the Clear Fork material.

Clear Fork

Clearly dominating the site in volume and material, the Clear Fork occupation levels yielded one-fourth of the total faunal remains. The heaviest concentrations of animal bones for the Clear Fork levels were found at Area C. The four levels assigned to this phase at Area C indicate either a cooking site or a kitchen midden because the majority of the burned bone for Clear Fork is found in these levels. Minimum number of individuals is also greater here than at any other excavation unit at the site (Table 15.7-8).Area E ranks next in species diversity and has slightly greater density for deer and rodent than Area C. The remaining areas have 30 identifiable elements each and add no new species to the Clear Fork assemblage. Area D, however, has the highest percentage of identifiable bones relative to total bones recovered from that excavation area (Tables 15.7 - 10,11 and Appendix C).

Species identified in all of the Clear Fork levels at 41WM56 are listed in Table 15.7-G. Thirty-six separate taxa are identified which ties this component with a transitional component in 41WM73 as having the most variety among the North Fork sites. Some animals are found exclusively in this component. Of all North Fork sites, evidence of bat and crayfish are found solely in this component at 41WM56. Remains of raccoon, badger, turkey, and bullfrog occur in this component and in only 3 others at North Fork. This component yielded the only freshwater drum and shark remains identified from either reservoir, and it ranks first in total number of turtle shell fragments.

Clear Fork is the only component at 41WM56 that contained representatives of all vertebrate classes (Table 15.7-5). Mammals and reptiles are most frequent and fish are well represented with at least four species identified. Birds and amphibians are evident as utilized taxa although in lower frequency, which is surely the result of the delicate nature of their osteological elements. Rodent remains are abundant and not conclusively intrusive because many elements are burned.

More deer occurs in this component than in any of the other cultural zones among the North Fork sites. These levels contain a minimum number of 5 deer based on 4 adult right calcanea, and loose deciduous teeth from at least one fawn less than 4 months old at death. The milk teeth are found in levels 6 and 9 of Area C. The remaining teeth are from deer aged around 2-4 years. Antler fragments indicate the selection of bucks, however, the presence of females is indeterminable. Thirty-three percent (n = 40) of the identified deer elements are burned. All body parts are represented in the sample suggesting that the entire carcass was transported

to the site, an indication that available game was nearby. The presence of deciduous teeth support a late spring-early summer occupation for these levels but does not exclude the possibility of year-round or sporadic occupation.

All of the species can be obtained throughout the year making seasonality assessment difficult at best. Winters in Central Texas are rarely severe enough to cause exclusion of specific animal resources.

The makeup of the faunal assemblage indicates that both grassland and forest habitats were exploited. Jackrabbit, badger, pronghorn and bison are found with fox squirrel, deer, raccoon and turkey. Aquatic habitats were also important as food procuring areas as indicated by remains of beaver, 4 species of turtle, bullfrog and smaller frogs, and at least 3 species of fish.

Although determination of species for the majority of the fish remains is not possible, most of the vertebrae are from small fish such as gizzard shad or bluegill. The smallest vertebra is 1.8 mm in diameter and 1.6 mm long, and the largest is 8.1 mm in diameter and 5.4 mm long.

The freshwater drum element is a single small pharyngeal tooth. No otoliths were recovered. The size or age of the fish cannot accurately be determined because these teeth are continuously produced and lost by the fish and vary in size naturally. This species is a spring spawner and prefers sluggish streams with clay or sandy substrates where it feeds along muddier bottoms (Burr, 1932; Cleland, 1966; Kemp, 1971).

The turtle genera (Chrysemys, Kinosternon, and Trionyx) also prefer slow-moving waters with soft bottoms (Ernst and Barbour, 1972). Therefore, these aquatic turtles define the nature of that portion of the San Gabriel near 41WM56 as torpid and turbid during the Clear Fork Phase.

The shark tooth found in level 9 of Area C is quite likely unassociated with the cultural material because light-colored shark teeth of the Squalicorax genus are very common in the upper Cretaceous sediments of Central Texas (Charles Finsley, personal communication). It was not found with any other coastal remains which would give evidence of trading, nor was it found in a feature. Furthermore, the only Holocene shark known to enter freshwaters to any distance, the bullshark, has entirely different teeth.

The burned crayfish pincer is another indication of the importance of the aquatic resources to the Clear Fork people.

Round Rock/Clear Fork

Transitional evidence between the Round Rock and Clear Fork horizons occurs only in levels 6 and 7 of Area B at the Hawes Site. Twelve percent

(n = 59) of the 476 bone fragments are identifiable. Mammals are highest in frequency followed by reptiles and fish. Amphibians and birds are not represented.

Deer and rabbit are expectedly the most common species. Unspecific mammal elements are numerous owing to the generally fragmented, poorly preserved state of all the bone. Additional bison is suspected in the large mammal category, and dog may comprise most of the medium mammal category.

No new species are found although identifiability remains the same as in the Clear Fork and San Geronimo phases. Moreover, species diversity drops and species determination for turtle and fish is inconclusive. Grassland and forest species are both represented, but aquatic species are under-represented suggesting a dryer period or a change in dietary preference during the transition.

Round Rock

With an increase in total bone, there is a corresponding increase in species diversity (Table 15.7-F). Round Rock components are found at Areas B and C from levels 4 and 5 where 3,044 fragments were recovered. Again, approximately 12% (n = 390) of these are identifiable and all vertebrate classes except Amphibia are represented. The same ranking of vertebrate classes exists here as in the other components with mammals first, then reptiles, fishes and birds.

There is no significant change in the species utilized nor in their relative abundance. A slight increase in percentages of rabbit and deer is evident when compared to the Clear Fork component. Non-mammals are also about the same.

A minimum number of 2 deer is represented in each excavation area, but MNI is based on 2 left astraguli in Area C and 2 different age groups (based on tooth wear) in Area B. Since the excavation areas are only 20 meters apart, the likelihood that parts of the same 2 deer exist in each area. Distribution of the elements indicates no activity differences between the areas because both are limited to non-meaty elements (antlers, teeth, vertebrae, feet) suggesting butchering activity. Only a small burned posteroproximal fragment of a tibia was identified as coming from a limb element. The unidentifiable deer-size fragments may be from smashed long bones further suggesting an ancillary activity of bone grease processing.

Pronghorn elements, primarily teeth fragments, are most dense in the Round Rock components. None is burned. Minimum number is not computed because of the small sample and uncertainty in distinguishing fragmentary remains of pronghorn from deer.

The bison elements are restricted to Area B and consist of two proximal scapula fragments and a tooth root in socket. The posterior ridge fragment of the scapula is charred, and loss of the enamel from the tooth may have resulted from heating as well.

Area B yielded the only dog element identified from this component. It is an unburned mandibular premolar fragment. At least two other fragments, a burned tooth and eye orbit, are relegated to the medium mammal category because of poor preservation and their fragmentary state, but these may also be from a dog species.

Even though only 12 jackrabbit bones were recovered, 3 individuals are indicated by 3 left distal tibiae which is the highest MNI for this species in all components at Hawes. If one hunt produced an abundance of jackrabbit, it is conceivable that established patterns of meat distribution would operate giving some members specific body parts.

Rodents are most prevalent in the Round Rock levels with more elements identified as pocket gopher than any other rodent species. Two-thirds of the gopher remains, however, are loose teeth. Furthermore, this species is well-known as an intrusive in many archaeological sites (Butler, 1980; Ferring, 1982). Amongst the 20 gopher elements recovered from Area C, however, 2 are burned suggesting that this animal may have served as a food item unless the burned elements represent the victim of a natural fire. Pocket gophers are native to the area and the genus is also known from Pleistocene times in Central Texas (Lundelius, 1967). They are occasionally carnivorous (Caras, 1967) and probably account for much of the rodent-gnawed bones recovered from archaeological sites. They are undoubtedly attracted, like other rodents, to refuse piles not only for bones but especially for vegetable matter.

Cotton rats and woodrats are other native rodents found in this sample with burned elements from each. Although unburned, 1 least shrew mandible was recovered from Feature 2 and is the only evidence of this species in the North Fork sites.

Aquatic taxa maintain adequate representation signifying their contribution to the subsistence of these people. Compared with the transition levels, more elements are identified to genera or species which is probably a reflection of the greater sample size. A decrease in frequency of elements, however, is noted when compared with the Early Archaic components suggesting a de-emphasis on aquatics in favor of land mammals.

Two bird elements are preserved well enough to be assigned to vertebrate class, but no further identification is possible. The elements are unburned and may not have any cultural significance, although, birds were surely utilized.

Seventeen per cent of all the identifiable bone is burned, and most burned bone originates from Area C where 24% of the deer elements are burned or charred.

More antler fragments are burned than any other element, and while no wear is evident on the antler pieces, they may have served as skewers or prods and, therefore, as cooking utensils. Bone tools were found at this site and are discussed in the following section.

Butchering marks are found on very few fragments in the Round Rock levels. Poor preservation of bone surfaces may account for the obscuring of lighter butchering scars. A deer axis from Area C is notable because of several deep cuts along the anterior articular ridge probably inflicted when the head was severed from the spine.

In summary, density of faunal remains from the Round Rock Phase at 41WM56 is greater than that from any other component (1,087/cm^3) and marks a pivotal zone in the utilization of the site. Even though the succeeding zones in Areas A and D contain a mixture of Round Rock and San Marocs lithics it is quite probable that most faunal material there is associated with the Round Rock Phase at Areas B and C and represents extended activity areas with less intensive utilization (see Feature discussions).

San Marcos/Round Rock

Despite the decrease in species diversity (Table 15.7-I) small sample size prohibits comparison between this transition and the phases that precede or follow it. How much or what taxa belong to which culture group is indeterminable.

Densitites for deer and rabbit do not decrease significantly in comparison with densities for these species found in the Round Rock levels. Dog is the only species with a notable increase in recovered elements. Furthermore, there is evidence that dog (either domestic or coyote) was used as a food item because one element is burned. Utilization of dogs as food may be indication of periodic ritual feasts or the need for emergency provisions (White,1955, Gilbert, 1969, Cleland, 1966). The collection of dog remains is too small to indicate intentional burial.

San Marcos

A volume of .7 m^3 was excavated and identified as San Marcos occupation. This phase occurs only in the lower levels of Area F. Fifty bones were recovered from these levels and only one unburned turtle shell fragment is identifiable (Table 15.7-E).

Twin Sisters

Of the 73 identifiable bone fragments, 37% are identified as deer with another 26% relegated to the large mammal element category. Some of the bones from this category are probably deer but are not whole enough

for absolute identification and because the presence of cow/bison elements prohibits certainty of identification of these small fragments as deer. Nevertheless, these three categories of artiodactylae dominate the identified sample (Table 15.7-D).

Fish, especially catfish, are present in equal amount to rabbit and pocket gopher indicating some utilization of aquatic resources. All of the catfish elements are burned and probably represent only one individual all from Feature 7.

Upper Levels

The first few levels in several excavation areas have been disturbed by plowing or land clearing activities. These activities cause mixing of the artifacts from the later occupations and tend to blur the analysis of these horizons. The first four levels of Area C are especially problematic because 54% (11,779) of the total bone from this excavation area is found in level 1-4.

In Table 15.7-8 these levels are lumped together. However, analysis of the faunal material from each of the four levels shows that there is a marked increase in species diversity and density in levels 2 and 3 (Table 15.7-9). When compared with the Round Rock Phase, the number of identified deer elements drops sharply from mixed level 4 to Round Rock level 5, and several species present in the upper 4 levels are not present in the Round Rock component. For example, dog, raccoon, beaver and frog are not found in the Round Rock phase and rabbit, antelope and birds increase only slightly. The interpretation of these discrepancies is confounded by the interfusion of heterogeneous material. It is clear, however, that faunal utilization is great in levels 2 and 3 and decreases overall by Round Rock level 5. The causal factors for this decrease is unclear.

Summary

The faunal remains from the Hawes Site show no clear evidence for substantial hunting differences between the various cultural components. In raw numbers per level, bone concentrations directly correspond with densities of cultural artifacts. The composition of identified species does not differ radically through time indicating no dramatic climatological changes strong enough to alter the habitats of prey animals.

Fauna in all phases is characterized by deer, rabbit and turtle. Aquatic species are more important in the earlier periods. Many species are identified from this site and several occur almost exclusively here especially during the Clear Fork occupation.

Preservation is rather poor and butchering marks are seldom detected. Burned bone is not abundant. Many fragments and elements reveal a similar pattern of burning often restricted to the broken edges of the pieces, whereas the remainder of the bone is uncharred. This evidence suggests a cooking method whereby meat is removed from the bone, either before or after roasting, and then the bone is returned to the fire so that the periosteum can be burned away allowing a clean break from which to obtain the marrow (Gilbert, 1973). Bones of large or medium-sized animals more often have burning patterns like this than do smaller animals probably because smaller creatures were roasted whole after skinning. No variance in burning pattern is distinguishable between the cultural zones.

Identified deer elements are generally non-meaty parts of the body suggesting a practice of returning the entire carcass to camp. From the evidence, it appears that this practice was continued during succeeding occupations.

Features

A total of 21 features were designated at the Hawes Site with 11 formal hearths, 7 burned rock clusters and 1 pit (2 others are unclassified). Some of the burned rock clusters may have functioned as hearths but are either poorly defined or otherwise indistinct.

The majority of features (n = 7) come from the Clear Fork and the San Geronimo zones (n = 4) and most are found in Area C (Table 15.7-13). The archaeological aspects of these features are discussed elsewhere in this report according to their cultural affiliation. The following description of faunal remains is given for each feature in numerical order.

Feature 1 (Area F) Burned rock cluster. Twin Sisters.

None of the 21 bone fragments recovered is identifiable, and only 1 fragment is burned.

Feature 2 (Area B) Burned rock cluster. Round Rock.

Most of the 142 fragments found in this basin-shaped depression are small pieces from small to medium-sized mammals. Twenty-one are burned to some degree and 26 are identified. Rodents, reptiles and fish constitute the bulk of the identifiable bone. Large mammals are represented by two teeth enamel fragments and a few unidentifiable long bone splinters. Of the rodents, pocket gopher and woodrat are represented only by unburned teeth, and if utilized as food items, their remains suggest that the skulls were discarded separately from the meal refuse. The only indication of least shrew at North Fork was recovered from this feature but may be intrusive. Rabbit is the most commonly identified animal with 1 humerus, one scapula and five loose teeth recovered. None of the rabbit bones is burned.

Table 15.7-13 Feature Bone Totals

Site 41WM56

Provenience			Unidentified + Identified			Identified Only			
Area	Feature	Level	#B	#UB	Total	#B	#UB	Total ID	Component
A	3	3	7	33	40	1	2	3	Twin Sisters
	4	4+5	30	83	113	2	5	7	San Marcos/ Round Rock
B	2	4	21	121	142	3	23	26	Round Rock
C	6	3	81	288	369	2	32	34	plow zone
	9	3	102	293	395	0	12	12	plow zone
	11	5	3	11	14	0	7	7	Round Rock
	14	9	27	124	151	2	8	10	Clear Fork
	15	9	14	51	65	0	5	5	Clear Fork
	18	8	4	28	32	1	14	15	Clear Fork
	19	7	13	29	42	0	1	1	Clear Fork
	20	9	1	1	2	-	-	-	Clear Fork
	21	12	0	1	1	-	-	-	San Geronimo
D	8	6	8	41	49	0	5	5	San Marcos/ Round Rock
	12	8	0	1	1	-	-	-	Clear Fork
E	10	7	9	20	29	2	3	5	San Geronimo
F	1	3	1	20	21	-	-	-	Twin Sisters
	7	3	11	29	40	3	4	7	Twin Sisters

No bone recovered from C F-5 Lv 6, D F-13 LV 10
F-16 LV 10,
F-17 LV 11

Burned elements are limited to non-mammalian remains such as two turtle shell fragments and 1 poisonous snake vertebra. Other non-mammals identified include gar, unspecified fish, and non-poisonous snake.

If this feature functioned as a cooking area, small game seems to be of substantial importance.

Feature 3 (Area A) Basin-shaped hearth. Twin Sisters.

Less than 45 bones are associated with F-3 with only 7 burned and 3 identifiable. Deer and dog comprise the identified remains, and the dog element (a tooth fragment) is burned.

Feature 4 (Area A) Burned rock cluster. San Marcos.

This feature ranks 5th in total bone recovered from all features at the Hawes Site. Twenty-six percent of the 113 bone fragments are burned, but only 7 of the total are identifiable. Animals identified include deer, dog and rabbit. Only the deer elements are burned, and they are primarily feet elements (metatarsal fragments and phalanges). Dog and rabbit remains are dental and unburned.

Feature 5 (Area C) Hearth. Clear Fork.

No bone recovered.

Feature 6 (Area C) Basin-shaped hearth. San Marcos.

Ranking second in total bone (369 fragments), this hearth has indications of continuous use because of the wide variety of species recovered. Unfortunately, only 9% of the total are complete enough for identification, and yet 7 mammal, 4 reptile and 3 fish species are identified. These include rabbit, jackrabbit, pocket gopher, pocket mouse, cotton rat, woodrat, and deer; turtle, lizard, poisonous and non-poisonous snakes; catfish, gar and a smaller fish.

Turtle shell fragments are the only burned bone in the identifiable sample although 22% of the total bone showed eivdence of burning. Fragmentation of the burned bone is great. Unburned fragments are mostly of large mammal size and may have been rendered for "bone butter." Collagen tests are planned to see if they had been boiled longer than comparably-sized bones found outside the hearth area.

One modified bone fragment, a small tubular "bead," was recovered from this feature. (Chapter 14.7).

Feature 7 (Area F) Burned rock cluster. Twin Sisters.

Forty bones were recovered with 11 burned and 7 identified. Three of the identified remains are burned elements from turtle and catfish. A single tooth fragment from a large mammal complete the identifiable sample.

Feature 8 (Area D) Burned rock cluster. Round Rock.

Another rock cluster with a small faunal scatter, this feature yielded 49 bones of which 8 are burned. None of the 5 identifiable pieces is burned, and they consist of rabbit, jackrabbit, pocket gopher, and non-poisonous snake.

Feature 9 (Area C) Basin-shaped hearth. San Marcos.

Although smaller than F-6, this feature contained more faunal remains than any other at the Hawes Site with 395 fragments of which 26% are burned. The bones are highly fragmented resulting in very few identifiable elements. Of the 12 pieces that could be identified, 2 burned feet elements compare well with pronghorn antelope and 1 burned antler fragment may also be antelope. Otherwise, only 3 teeth fragments and unidentifiable splinters account for large mammals. The remainder of the identified sample consists of rabbit and woodrat teeth and snake and fish vertebrae. Only the large mammal remains are burned.

Feature 10 (Area E) Pit. San Geronimo (?)

As the only feature from Area E and the only designated pit, F-10 yielded very little osteological material. Twenty-nine bone fragments were recovered of which 9 are burned and 5 are identified. Since the bone was recovered deep in the pit (Level 9) and the originating living surface is obscure, the faunal remains are quantified with the San Geronimo phase. The identified speices offer no clues as to the culture group that deposited them. Rabbit and turtle are the identified fauna, and 1 element of each is burned. The function of this feature as a refuse pit is neither confirmed nor refuted by the faunal remains found there.

Feature 11 (Area C) Burned soil. Unknown.

Cultural association of this feature is questioned. (See feature description, this volume.) The possibility exists that the burned rocks, soil, and charcoal are the natural results of a localized fire. Only 14 fragments of bone were recovered, and

of these, 3 are small burned chips. Five elements are ident able as small or medium-sized mammals, mostly rabbit and squirrel, and none of these is burned. The fauna from this feature could easily be prey remains of a fossorial predator some of which were fortuitously burned.

Feature 12 (Area E) Burned rock cluster. Clear Fork.

Only 1 burned, unidentifiable bone fragment was recovered. It shows evidence of rodent gnawing.

Feature 13 (Area D) Hearth. Clear Fork.

No bones are reported for this feature.

Feature 14 (Area C) Double hearths. Clear Fork.

Since both hearths are considered contemporaneous, no attempt was made to separate the bone. With 151 recovered fragments, this feature ranks third in total bone, and has the most bone of all Clear Fork features at WM56. Again, like F-4 and F-9 from San Marcos levels, fragmentation restricts accurate identification, allowing only 12 identifiable elements. Small mammals are represented by 1 jackrabbit tooth, 1 cotton rat humerus and 2 rodent incisors, 1 of which is burned. Burned rodent elements are interesting because rodents are generally accepted as intrusives, and yet when a burned rodent element is found in good cultural context, investigators need to consider how easily rodents are lured and trapped (especially near refuse piles) and consequently consumed. Rodents procured near base camp could furnish enough animal protein during periods when larger game is unavailable.

Large mammals are represented in this feature by one deer humerus fragment and some burned teeth fragments from a deer-sized animal.

Three turtle shell fragments complete the identified material from the feature fill.

Feature 15 (Area C) Hearth. Clear Fork.

With the exception of F-14, most Clear Fork features contain few faunal remains. For example, F-15 yielded 65 fragments of which 14 are burned and only 5 are identifiable. The identified animals include dental fragments from a woodrat and a larger mammal, probably deer, and 1 small fish vertebra. None of the identified remains is burned.

Feature 16 (Area C) Hearth. San Geronimo.

No bone recovered.

Feature 17 (Area C) Hearth. San Geronimo.

No bone recovered.

Feature 18 (Area C) Burned rock cluster. Clear Fork.

Almost half of the small amount of bone (n = 32) from this feature is quantified as identifiable. The osseous material is just as fragmented as at other Clear Fork features and, therefore, identifications are largely limited to vertebrate class with deer being the only exception. The mammalian remains are separated into large, medium, and rodent-sized elements which are entirely dental (again except deer). Two elements are identified as deer, a humerus fragment and ulna fragment, both from the right side and probably from the same adult individual. Butcher marks are not visible, and none of the mammal bones is burned. Non-mammals consist of a vertebra from an undertermined species of snake (burned) and a small fish vertebra (unburned).

Feature 19 (Area C) Hearth. Clear Fork.

This Clear Fork hearth has only 10 more recovered bone fragments than F-18, but more are burned (13) and fewer are identifiable (1) (Table 15.7-13). The single identified bone is a fragment of tooth enamel from a large mammal. The unidentifiable remains also appear to be fragmented limb bones from large mammals, most likely deer.

Feature 20 (Area C) Hearth. San Geronimo.

Only 2 pieces of bone were recovered, one burned and one unburned. Neither is identifiable

Feature 21 (Area C) Burned soil. Unknown.

At first this feature appeared to be a possible hearth. Any cultural associations have now been dismissed. Only 1 unburned bone fragment was recovered.

Feature Summary

Fragmentation at the lower levels restricts positive identification of animal remains found in San Geronimo and Clear Fork features. With few exceptions, the types of fauna in the features do not differ substantially throughout the site's occupation. Deer, rabbit, rodents, snake, turtle, and fish are most commonly found.

The distribution of bone, rather than identified species, may be more revealing. For instance, 4 of the Early Archaic hearths (F-5 and F-13, Clear Fork; F-16 and F-17, San Geronimo) contained no bone at all. The other Early Archaic features yielded less than 50 fragments with only 2 exceptions, the double hearth F-14 (151 fragments) and F-15 (65 fragments). The 2 hearths associated with the San Marcos Phase (F-6 and F-9) contained as much bone (764 fragments) as all the others combined. Using fragment counts can be misleading if differential preservation or fragmentation exists between upper and lower levels. However, no differences were noted in these samples. Therefore, either natural or cultural processes occurred causing a dichotomy in the quantities of bone fragments between Early and Late Archaic features.

In the Hoxie Bridge report, C. L. Bond observed the effects of flooding on modern fishermen's campsites, noting that the majority of artifacts left in fire hearths were scoured out by the rushing water, leaving virtually no traces (Bond, 1978). The rocks were generally undisturbed, but remains such as chicken and steak bones were absent after flooding. This site is situated between the North Fork and a currently intermittant stream and easily could have been flooded repeatedly in antiquity.

Flooding, however, would seem to affect surface features like burned rock clusters more than depression features such as basin-shaped hearths. Slightly more bone is found in the clusters (if the San Marcos hearths are excluded) than in the hearths, suggesting that the clusters may be refuse areas for cleaned-out hearth debris. The 2 San Marcos hearths were quite full of meal remains abandoned perhaps before being cleaned out.

Each cultural component contained both hearths and burned rock clusters usually found in different excavation areas (Table 15-7-13). For example, the Twin Sisters hearth is located in Area A, but burned rock clusters for this occupation are found on the terrace edge at Area F. Since most of the cultural components evince substantial temporal occupation, it is reasonable to assume that the residents would re-use cooking hearths, clean them periodically, and deposit the debris in suitable areas outside the living quarters. This hypothesis requires extensive spatial analysis of the relationship of hearths and burned rock clusters not suitable in this analysis. Furthermore, the hypothesis that clusters are trnasient, informal hearths cannot be totally discounted.

Site 41WM57

Located a short distance (200 m) from the Hawes Site with its abundance of faunal remains, 41WM57 is a large site which contained a relatively small amount of bone, 2,744 fragments. Nine excavation areas and several trenches yielded artifacts from San Geronimo, Clearfork, and Round Rock Phases but primarily from levels associated with a transitional period between the Round Rock and San Marcos components. Osteological material corresponds with other cultural debris in that the most bone comes from the upper levels which are mixed from disturbances caused by land clearing, agriculture, and pot-hunting. A few areas contained 1 or 2 middle levels of unknown cultural affinities, and, with the mixed plow zone levels, are not calculated for the following table (Table 8.5-14).

The levels with good cultural context contained very little bone, but the numerous transition levels yielded a moderate sample. No densities were computed for any of the samples from this site. Preservation is extremely poor accounting for less than 7% (n = 151) of the total bone as identifiable.

San Geronimo

The only material from the San Geronimo component was recovered at the bottom of Area G. Only 2 out of 16 bones are identifiable. These include a burned turtle shell fragment and a burned catfish pectoral spine fragment. This catfish element is the only fish remnant recovered from this site and is relatively significant because it comes from the early occupation zone similar to the relative abundance of aquatic remains in the lower levels of the Hawes Site nearby, again suggesting occupation during wetter times. Additionally, almost ½ (n = 7) of the recovered bones from this phase are burned, but the sample is exceedingly small.

Clear Fork

Identified remains from these levels are characterized by animals that are particularly fond of sandy habitats--jackrabbit, pocket gopher, and cotton rat (Table 15.7-15).Two deer are minimally represented by very small fragments from elements such as the ulna, pelvis, metapodials and teeth enamel. The turtle fragments are very small and damaged, therefore, no species determination is attempted. Located in only one excavation area (E), bone from this occupation numbered 201 with 17 elements identified (Table 15.7-G).

The sandy soil preference of the small mammals helps reconstruct the environment of the site as it developed upon the alluvial fan. Cotton rat elements do not appear again at this site and the frequency of jackrabbit remains lessens through time.

TABLE 15.7-14. Faunal Summary for 41WM57

COMPONENT	SAN MARCOS/ ROUND ROCK	ROUND ROCK	CLEAR FORK	SAN GERONIMO
AREAS	A Lv 3-4 B Lv 3-5 C Lv 4-5 F Lv 3-6 G&H Lv 5-6 I Lv 1-3	D Lv 3-6 E Lv 2-3	E Lv 4-6	G Lv 7-9
Vol. m^3				
TOTAL BONE	740	243	201	16
DENSITY				
# ID	45	23	17	2
% ID	6.0	10.0	9.0	12.5
MAMMALS	*93.0%*	*96.0%*	*82.0%*	-
BIRDS	-	-	-	-
REPTILES	*7.0%*	*4.0%*	*18.0%*	*50.0%*
AMPHIBIANS	-	-	-	-
FISH	-	-	-	*50.0%*
TOTAL % BURNED	24.0	29.0	39.0	44.0
ID % BURNED	24.0	13.0	6.0	100.0

TABLE 15.7-15. *Species List for 41WM57*

Total Number of Elements per Component

	PLOW ZONE	SAN MARCOS/ ROUND ROCK	ROUND ROCK	CLEAR FORK	SAN GERONIMO
Rabbit	3	1	1		
Jackrabbit	1		1	3	
Pocket Gopher	1	1		1	
Cotton rat				1	
Woodrat			1		
Dog	9	1			
Deer	26	33	17	5	
Pronghorn	2				
Bison	9	3	1		
Rodent				1	
Small	1	2			
Medium	1	1	1	3	
Large	3				
Turkey	1				
Turtle sp.	5	2	1	3	1
Musk/Mud Turtle	1				
Snake sp.	1	1			
Catfish					1
Totals	64	45	23	17	2

Thirty-nine percent (n = 78) of the total bone is burned including the cotton rat tibia which suggests utilization of this rodent as a food item. None of the identified deer elements are burned, but this certainly does not imply that unburned deer elements indicate deer as an intrusive species, only that fire did not scorch the meatier bones if/when the meat was roasted.

Round Rock

Two excavation areas (D and E) contained Round Rock materials including 243 pieces of bone of which 70 are burned and 23 are identified. The number of deer elements increases, but again they are not burned. The meatier elements include small fragments from the ulna and radius and the remainder are usually uncooked elements such as teeth and ankle bones.

Two bison bones were identified in this small sample. They are a sub-adult molar from level 4 at Area D and a seoncd phalange from level 2 at Area E. Neither element is burned. No butchering marks are visible.

The first indication of small lagomorphs appears during this phase as a burned and broken scapula from either the eastern cottontail or the swamp rabbit. Both rabbits occupy riverbottoms in Williamson County (Davis 1974) and are extremely difficult to distinguish osteologically from tiny fragments.

Other animals include jackrabbit and woodrat, both of which can be hunted on more arid uplands near this site. Woodrats also occupy swamplands. The turtle fragments are probably mud turtle but are too small and deteriorated for accurate species determination. However, they appear to be from an aquatic species rather than from the terrestrial box turtle.

Identifiable burned bone includes the turtle shell fragment, the rabbit scapula and a canine tooth from a medium-sized mammal, probably a dog or coyote. The tooth root is charred and all enamel has burned away suggesting roasting or cremation of the entire body of the dog.

Poor preservation has eliminated the opportunity to study butchering patterns. The fragments are quite small, pitted and root etched, effectively obliterating any cut marks.

San Marcos/Round Rock

Of all designated cultural zones, the levels containing artifacts from both San Marcos and Round Rock Phases yielded the most bone (740 fragments). These transitional levels were found in every excavation

unit except D and E where Round Rock and Clear Fork artifacts are concentrated. This transitional zone represents the greatest temporal and areal span of occupation at the site.

Zoologically, the species present in these levels do not differ from the earlier periods. The only new species identified is poisonous snake represented by one broken vertebra. Dog is identified from an unburned tooth fragment but again, exact species is indeterminable.

Of the large mammals, deer bone differs from the earlier material by occurring in larger, mostly burned fragments from meaty elements such as the humerus (which is charred), tibia and pelvis. Other elements include non-meaty body parts such as metapodials, calcanea, teeth and antlers. The presence of such diverse elements at a camp site suggests that the entire carcass was brought back and prepared on site.

Three deer are represented by 3 right proximal metacarpal fragments. None of these pieces show evidence of tool manufacture as might be expected of these elements which are often made into tools. However, these elements may have been curated for future tool fabrication.

Three bison-sized fragments were recovered from the transition levels in Areas A and B. One fragment is a very deteriorated portion of a right distal humerus from Area A. It was found with a longitudinal section of tooth enamel also of bison morphology. A shaft fragment from Area B appears to be a medial area of a left humerus. None of these elements is burned or cut. Considering the girth of a fallen bison, it is possible that these isolated elements are actually associated with the disturbed upper levels where several bison elements were recovered.

Mixed Upper Levels

The first 10-20 cm of most units are considered disturbed plow zones. Nevertheless, a great deal of faunal material (1,104 fragments from Area G alone) was recovered. Because of poor preservation, identified remains are limited to roughly 5% of this sample with deer, bison and dog as the most common species noted.

Of all the deer elements recovered (n = 26), a minimum of one adult individual is represented. The extreme wear on the teeth suggest an old deer, approximately 5-7 years of age at death. An antler base fragment was recovered but the pedicle is not attached, therefore, hampering seasonality assessment.

As nentioned above, bison bones are most numerous in the disturbed levels. Nine bison-sized fragments and elements were recovered, mostly from Area G. One is slightly charred along one of its broken edges, although none show direct burning. Besides phalanges and vertebral

fragments, the only specific element identified is a left distal humerus broken longitudinally into 2 pieces. The articular end is very battered and/or chewed, and the diaphysis of the larger piece ends in a deep spiral fracture. No cutting marks are visible. The remaining fragments are from long bone shafts and possibly a proximal tibia. All of these fragments are tentatively identified as bison because they were recovered near the surface. Since none come from above level 3 where there is some indication of Twin Sisters occupation, it seems safe to assert that they are in sediments which are much too early for the bones to be from European cattle.

All nine of the fragments assigned to dog species are teeth fragments from Area G. One canine root has been burned which resulted in loss of the enamel. All of these pieces are very badly eroded and nothing more than their presence is noted.

Small mammals include some rabbit, jackrabbit, and pocket gopher elements, although in scant numbers. Reptiles include one snake vertebra and several turtle shell fragments, one of which comes from a member of the Kinosternidae family, probably a small or young yellow mud turtle.

Two species are found exclusively in these mixed levels, turkey and pronghorn. Only one element from each is recorded. The turkey bone is lightly burned. The pronghorn element is definitely identified from its diagnostic hoofphalange. The presence of these two animals and others suggests increased utilization of the upland prairies.

Features

A total of 70 bone fragments were removed from 3 of the features at this large site. Less than 5 of these are identifiable to any degree as large mammal teeth enamel and turtle shell fragments, and none of the identifiable pieces are burned. Twenty of the 70 feature bones are burned and most of these come from F5 and F6 which also contained most of the total feature bones. Few reliable inferences can be made from these small samples. However, it is possible that the lack of osseous material in the hearths is a result of water scouring.

Summary and Comments on Backhoe Material

Although is large and near the Hawes Site, the two differ markedly in quantities of faunal remains. Species diversity is low in all occupation zones, with deer as the most commonly identified animal. Turtle, rodents, and rabbits constitute the majority of small animal remains throughout time. Dog, pronghorn and bison are limited to the transition and mixed upper levels. Aquatic species are notable in the oldest levels. The overall paucity of bone material at this site is reasonably attributed to its nearness to water and subsequent hydrological actions such as scouring and general deteriorating effects.

Concerning evidence of butchering, poor preservation hampers recognition of cut marks. However, several small fragments from Areas C and D, Level 3 have notches around the broken edges. The notches are V-shaped and some are 2 mm deep. They appear to be intentional alteration, but their purpose is unknown.

The osteological material recovered from backhoe trenching deserves a comment here. Several large fragments from these tests are attributed to bison and deer, but more important, a human femur diaphysis fragment was also recovered. No other evidence of burial was found, and because the fragment was not recognized as human in the field, no further investigation was undertaken.

Site 41WM73

As described elsewhere, this classic burned rock midden is located on the back of a terrace at the base of an upland slope. Five units yielded 8,651 fragments of bone from approximately 16 m^3 of fill. Several backhoe trenches were placed to define the activity perimeters, but these yielded only 69 bone fragments altogether (Table 15.7-16).

Although snail analysis showed frequent flooding of the site, the osseous material is somewhat better preserved than that from other North Fork sites. The larger bones are not as pitted or etched; however, they exhibit surface splintering caused by wet/dry cycles. The bones in the lower levels of the midden are better preserved than those in the upper levels probably as the result of rapid burial.

Considered as a whole assemblage, species diversity is large. Like the Hawes Site, some species are found exclusively here. For example, ground squirrel, deer mouse, prairie chicken, bobwhite and box turtle are not identified from any other excavated site in the North Fork Reservoir area. Badger remains are identified from only one other site at North Fork, and no other site in either reservoir area contained identified elements from the bass/perch (Centrarchidae) family except 41WM73.

Four Late to Middle Archaic components are designated at this site with the Round Rock component appearing in every excavation area. As the following tables indicate, 8.7 m^3 of fill from 5 units are relegated to this cultural zone which contained over three thousand fragments of bone. Notice, however, that the Round Rock/Clear Fork levels at the base of the midden area in Area B alone contained only 2.5 m^3 of matrix and yielded over one hundred more pieces of bone. Considering the densities of bone only from Area B, the Clear Fork component has the lowest density at 465 fragments per m^3, the composite zone is greatest at 1,395 fragments per m^3, the disturbed sections (mixed levels) have 957 fragments per m^3, and the Round Rock component (5 m^3 in volume) yielded only 481 fragments per m^3. The disturbed section is an erosional feature with evidence of

TABLE 15.7-16. Faunal Summary for 41WM73

COMPONENT	SAN MARCOS	ROUND ROCK	ROUND ROCK/ CLEAR FORK	CLEAR FORK
AREAS	A Lv 1-5 E Lv 1-2	A Lv 6-10 B Lv 1-12 C Lv 1-9 D Lv 1-4 E Lv 3-11	B Lv 13-15* + Lv 16-17	B Lv 18-21 C
Vol. m^3	1.5	8.7	2.5	2.2
TOTAL BONE	210	3345	3488	937
DENSITY/m^3	140	384	1395	426
# ID	14	523	868	216
% ID	6.0	15.6	25.0	23.0
MAMMALS	*85.7%*	*71.9%*	*67.4%*	*65.3%*
BIRDS	-	-	*.6%*	*.9%*
REPTILES	*7.1%*	*24.7%*	*24.8%*	*25.9%*
AMPHIBIANS	*7.1%*	*.9%*	*2.9%*	*3.7%*
FISHES	-	*2.5%*	*4.4%*	*4.2%*
TOTAL % BURNED	46.6	37.0	42.0	41.0
ID % BURNED	35.7	31.7	38.7	30.5

* portions

rodent activity located in parts of 4 adjoining 1 x 1 squares (N1040 and 1041/W1050 and 1051). The density of bone in the Clear Fork/Round Rock composite component suggests that the midden originated during that occupation although species diversity does not appreciably change between Clear Fork and the composite compoent. All vertebrate classes are represented in these two components until birds drop out in the Round Rock Phase and fish decrease then finally disappear in the San Marcos component.

If identifiability is an index of preservation, then preservation is better in the lower levels where 23 to 25% of the recovered bone is identified at least to vertebrate class. In support of the hypothesis that burned bone is more friable and subject to faster decomposition (Cornwall, 1974; Ryder, 1968; Chaplin, 1971), notice that the percentage of burned bone is greatest in the San Marcos component where only 6% of the material is identifiable. On the other hand, percentage of burned bone is nearly as high in the 2 lowest components where identifiability is greatest. Other factors such as immediate burial (as in refuse dumping) or rapid sedimentation rates (from frequent flooding) probably played a determining role in the better preservation of the bone in the early components.

Since Area B was the only excavation area extended more than 3 units, the majority (85%) of total bones from the site were collected from it (7,400 out of 8,720). Over 1600 of the fragments from Area B are identifiable (Table 15.7-17) and all vertebrate classes are represented. Forty different taxa are identified from Area B whereas three other areas have between 9 and 13 each, and one (Area D) has only 2 identified taxa: a large mammal tooth fragment and 2 turtle shell pieces. Area C yielded 2 species not found in Area G, pocket mouse (Peromyscus sp.) and soft-shell turtle (Trionyx sp.) bringing the total number of taxa to 42, the majority of which were recovered from the composite levels between Round Rock and Clear Fork (Table 15.7-18).

Clear Fork

The fauna associated with the Clear Fork component is found in levels 18-21 of Area B and levels 10-13 of Area C. Density is moderate with 425 fragments per m^3. All vertebrate classes are represented in the identified material which comprises 23% (n = 216) of the total recovered bone (n = 937). Mammals and reptiles are again the most common classes identified. Aquatic fauna such as fish and amphibians are about equally represented, and much of the turtle remains are from aquatic types. Only 2 bird bones are identified, one of which compares well with prairie chicken (found only in this component at North Fork), and the other is of prairie chicken size.

Of mammalian species, rodents have the greatest density during this occupation with pocket gopher remains the most prevalent. Many of these rodent bones are burned resulting from either intentional roasting or fiery vermin disposal. Considering the paucity of deer remains, rodents surely provided a necessary protein source whether roasted or consumed uncooked (Williams-Dean, 1978).

Table 15.7-17. Total Number of Elements by Vertical Provenience, Site 41WM73.

AREA B

SPECIES	ROUND ROCK					ROUND ROCK/CLEAR FORK					CLEAR FORK					DISTURBED			
	Lv.	(T)	(B)	MNI	5.0m³	Lv.	(T)	(B)	MNI	2.5m³	Lv.	(T)	(B)	MNI	1.8m³	Lv.	(T)	(B)	MNI
Rabbit	64	(45)	(15)	2	12.80	117	(71)	(80)	5	46.80	19	(7)	(8)	2	10.55	16	(8)	(5)	1
Jackrabbit	14	(3)	(8)	2	2.80	32	(14)	(14)	3	12.80	7	(1)	(4)	1	3.88	12	(6)	(2)	1
Fox Squirrel	1	(1)	-	1	.20	3	-	-	1	1.20	1	-	(1)	1	.55				
Ground Squirrel											1	-	-	1	.55				
Pocket Gopher	68	(42)	(32)	8	13.60	143	(113)	(39)	9	57.20	25	(9)	(10)	4	13.88	35	(27)	(11)	3
Beaver	4	(4)	-		.80	5	(3)	-		2.00									
cf. Pygmy Mouse						1	-	-		.40									
Deer Mouse						1	-	-		.40									
Cotton Rat	2	-	(2)	2	.40	16	(1)	(1)	4	6.40	4	(1)	(1)	1	2.22	3	-	(2)	1
Woodrat	6	(5)	-	1	1.20	9	(7)	(3)	1	3.60	3	(2)	(1)	1	1.66	2	(1)	(1)	1
Dog sp.						6	(4)	(2)	1	2.40									
Raccoon						4	(2)	-		1.60									
Badger						5	(5)	(1)	2	2.00	1	-	-		.55	1	-	-	
Skunk						1	-	-		.40									
Deer	24	(10)	(4)	1	4.80	42	(6)	(13)	2	16.80	9	(5)	(1)	1	5.00	11	(4)	(4)	1
cf. Pronghorn	2	(2)	-	1	.40	1	(1)	-	1	.40	3	(2)	-	1	1.66				
Cow/Bison	1	-	-	1	.20											1	-	-	1
Rodent	73	(48)	(16)		14.60	134	(105)	(38)		53.60	39	(30)	(8)		21.66	13	(10)	(5)	
Small mam.	36	-	(11)		7.20	42	-	(21)		16.80	12	-	(4)		6.66				
Medium mam.	12	(6)	(5)		2.40	21	(16)	(15)		8.40	8	(5)	(1)		4.44	2	(1)	-	
Large mam.	1	(1)	-		.20	2	(2)	-		.80	1	(1)	-		.55	1	-	-	
Bird sp. small						1	-	-		.40									
Bird sp. medium						1	-	(1)		.40	1	-	-		.55	2	-	-	
Bird sp. large						1	-	(1)		.40									
cf. Hawk						1	-	-		.40									
cf. Prairie Chicken											1	-	-	1	.55				
Bobwhite						1	-	-		.40									
Snake sp.	8	-	(3)		1.60	11	-	(2)		4.40	3	-	-		1.66				
Viper	6	-	(2)		1.20	12	-	(5)		4.80	1	-	-		.55				
Colubrid	12	-	(6)		2.40	16	-	(8)		6.40	11	-	(4)		6.11	1	-	-	

Table 15.7-17. Total Number of Elements by Vertical Provenience, Site 41WM73, continued.

AREA B, continued

SPECIES	ROUND ROCK					ROUND ROCK/CLEAR FORK					CLEAR FORK					DISTURBED			
	Lv.	(T)	(B)	MNI	$5.0m^3$	Lv.	(T)	(B)	MNI	$2.5m^3$	Lv.	(T)	(B)	MNI	$1.8m^3$	Lv.	(T)	(B)	MNI
Turtle sp.	64	-	(22)		12.8	132	-	(48)		52.80	30	-	(13)		16.66	32	-	(16)	
Pond Slider	14	-	(6)		2.8	39	-	(25)		15.60	5	-	-		2.77	2	-	(2)	
Box Turtle						2	-	-		.80	2	-	(1)		1.11				
Musk/Mud Turtle						3	-	(1)		1.20	1	-	-		.55	2	-	(2)	
Frog	5	-	(5)		1.0	20	-	(3)		8.00	8	-	(2)		4.44	3	-	-	
Bullfrog						5	-	(5)		.20									
Fish sp.	7	-	(2)		1.4	28	-	(5)		11.20	7	-	(3)		3.88	5	-	(1)	
Catfish	5	-	(4)		1.0	9	-	(4)		3.60	1	-	-		.55	2	-	-	
Gar						1	-	-		.40	1	-	-		.55				
Bass/Perch	1	-	-		.2														
TOTAL ID	430					868					205					146			

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

Table 15.7-18 Total Number of Elements by Vertical Provenience, Site 41WM73

AREA C

Species	Round Rock					Clear Fork				
	Lv. 1-9	(T)	(B)	MNI	1.4m³		(T)	(B)	MNI	.m³
Rabbit	5	(4)	(1)	1	3.6	4	-	(2)	1	10.0
Pocket Gopher	5	(2)	(1)	1	3.6	1	-	(1)	1	2.5
Pocket Mouse	1	-	-	1	0.7					
Wood Rat	1	(1)	(1)	1	0.7					
Rodent	2	(2)	(1)		1.4	2	(1)	-		5.0
Small mam.	1	-	-		0.7	1	-	(1)		2.5
Medium mam.	7	(6)	-		5.0					
Deer	5	(2)	(5)	1	3.6					
Snake sp.						1	-	-		2.5
Viper	1	-	(1)		0.7					
Turtle sp.	8	-	(1)		5.7					
Pond Slider	1	-	-		0.7					
Soft Shell						2	-	-		5.0
Totals										

(T) = No. of teeth included in total.
(B) = No. of burned elements included in totol.
m^3 = Volume excavated and element density per taxon.

The identifiable deer bones number only 9 fragments, 5 of which are teeth fragments all from Area B. Area C contained no deer remains. However, some unidentifiable fragments of large mammal size are probably deer or pronghorn. Pronghorn teeth are identified from the Area B material. Explanations for this lack of large mammal post-cranial remains are difficult unless the site during the Clear Fork occupation served as a temporary campsite with specialized activities other than large game processing. Deer is well represented in Clear Fork components at other sites. Therefore, it is further possible that the scarcity here is the result of sampling (Table 15.7-G).

Analysis of the habitat preferences of the other mammals found in the component take on more significance when compared with the composite (i.e., mixed) component above it.

Round Rock/Clear Fork Composite

This component is limited to Area B and constitutes the origin of the large midden. Osteologically it is significant because 47% (n = 3,488) of all the bone recovered from Area B (and 40% of the total bone from the site) comes from parts of the 4 levels (2.5 m^3) assigned to this component. Granted that Area B is the largest excavation area opened, the density of bone in this component is very high at 1,395 per m^3.

The densities for each taxon is also high. For example, Table 15.7-17 shows the density for rabbit in the composite component to be 46.8 while in the preceding Clear Fork zone, rabbit bone density is 10.5 and 12.8 in the succeeding Round Rock levels. In fact, each density is consistently greater than its taxonomic counterpart in the "pure" Round Rock components from the combined excavation areas at 41WM73. Raw numbers are greater as well.

It is indeed enigmatic when adequate samples with high densities and calculable minimum number of individuals come from interfused components. Since it is virtually impossible to determine which fragments were deposited by which culture, the zooarchaeologist can only attempt to measure the amount of changes, in this case an increase in numbers of identified elements, and the presence or absence of certain species. Raw numbers and percentages for each species can be compared by component in Tables 15.7-G, 15.7-F, and 15.7-I for Clear Fork, Round Rock and Clear Fork/Round Rock comixture, respectively.

Twenty-eight taxa contain the identified species from the Clear Fork component and 24 are needed for the Round Rock fauna. The mixed component, however, requires 36 taxonomic categories, which is quite a bulge in species diversity between two homogeneous culture zones.

Only 2 species, ground squirrel and prairie chicken, are identified in the Clear Fork component that are absent in the composite and Round Rock materials. Both are grassland denizens.

Although all three components have grassland fauna in their assemblages, the composite period adds badger, pygmy mouse, and bobwhite quail, as well as jackrabbit, pronghorn and pocket gopher, which are present in each flanking component. Other additions found in the composite include woodland and streamside animals such as beaver, raccoon, skunk, and bullfrog. Bird and fish remains also increase in the composite levels.

Like the Clear Fork assemblage, rodents predominate in the composite sample. Pocket gopher remains have the highest density (57.2 per m^3) and account for over 16% (n = 143) of the sample. However, 79% (n = 113) of the pocket gopher elements are loose teeth which are easily identified and diagnostic for the species. Miscellaneous rodent elements are also high in density (n = 134 or 53.6 per m^3). In all, 6 species of rodents are identified at least to genus level, and 14% (n = 43 of 309) of the elements are burned. Again, the rodent bones gain significance because of the small number of large mammal remains.

Although density of deer bones is significant in the Round Rock/Clear Fork component (Table 8.5-19), deer ranks fifth in density and frequency. Rabbit ranks fourth, but at least 5 individuals are represented, whereas only 2 deer are minimally indicated. MNI estimates may be misleading because obviously 2 deer would provide more meat protein than 5 rabbits. However, 42 fragments of bone are scanty remains for 2 individual deer. Therefore, sampling error could account for this discrepancy.

Despite the possible sampling problems, comparisons of large mammals to small mammals suggest greater utilization of the smaller mammals based on raw numbers, density, frequency and minimum numbers. These at least were deposited time and again onto the refuse pile.

The ample quantities of burned bone in this component further suggests its use as a refuse midden. Of the total sample from the composite zone, 42% (n = 1,478 of 3,488) are burned. Furthermore, 39% (n = 335 of 868) of the identified bone is burned which means this component contains more burned bone than any other at this site.

Butchering marks are not evident on any of the identified elements. However, several fragments from the unidentifiable sample have light cuts. Many pieces are rodent gnawed and some may have been gnawed by dogs. Several dog teeth were found exclusively in this component.

Round Rock

The density of bone (384 per m^3) and species diversity (n = 24) diminishes substantially in the next component. However, the areal expanse of this cultural association is greater than any of the others being designated in each of the areas excavated at this site. The bulk

of the osteological material is again located in Area B where 2,405 fragments are associated with the Round Rock occupation. Unfortunately, to what extent the faunal material from the composite levels is actually associated with the designated Round Rock component at Area B will never be ascertained. A decrease in the use of the midden is apparent from the reduced amount of refuse.

The composition of the material changes also (Table 15.7-16). The frequency of mammals increase slightly while fish and amphibian remains decrease and bird remains are absent. Out of 3,345 fragments over 16% are identifiable (Table 15.7-F) with basically little change in species composition. For example, both grassland and woodland creatures are still represented and the relative frequencies of species such as jack-rabbit, pronghorn, deer, cottontail, pocket gopher, and turtles does not change through time, only the total number of elements decreases. Aquatic faunas also diminish in species and in total numbers. For example, turtle (sp.) remains drop 52% and fish remains drop 75% in raw numbers with an equally significant reduction in density.

The relative abundance of rodents stays constant even though the numbers decrease. The frequency of burned rodent bones increases, however. Medium mammals (skunk, raccoon, badger and dog) are absent. Some of the elements relegated to the medium mammal category may be from these species, but fragmentation prohibits exact species determination. Beaver is present in dental remains only and could be a natural occurrence since no burned elements were recovered.

Among the large animal remains, deer is again underrepresented when compared to rodents, rabbit and turtle. Most of the identified elements are teeth fragments, and few are burned. Pronghorn is present also but only by dental elements that are so fragmentary as to render this identification tenuous. The identification of bovine remains is positive. However, the element (a tibia fragment) was recovered in poor context somewhere between levels 1 and 9 in general fill, and therefore, may be archaeologically intrusive from modern cow although the appearance of the bone suggests a long interment because it is pitted and etched similarly to the archaeological specimens. If it is bison, it is the only fragment from the entire site to indicate the presence of this animal.

San Marcos

This component was located only in 2 closely associated excavation areas, A and E (Table 15.7-19). A total of 210 fragments were removed from 1.5 m^3, resulting in the faunal remains having very low density (84 per m^3). Most of the pieces are from medium to large-sized mammals but are quite fragmentary restricting accurate species determination (Table 15.7-E). Only 14 bones are identifiable. The non-bone artifacts

Table 15.7-19. Total Number of Elements by Vertical Provenience, Site 41WM73

AREA A

	San Marcos					Round Rock				
Species	Lv. 1-5	(T)	(B)	MNI	1.0m³	6-10	(T)	(B)	MNI	.9m³
Rabbit	1	-	(1)	1	1.0	1	-	(1)	1	1.11
Jackrabbit	1	(1)	(1)	1	1.0					
Pocket Gopher						1	(1)	-	1	1.11
Woodrat	1	-	-	1	1.0					
Deer	1	-	(1)	1	1.0	2	(1)	(1)	1	2.22
Rodent						1	-	-		1.11
Medium mam.	5	-	(1)		5.0					
Large mam.	3	(3)	-		3.0					
Turtle Sp.	1	-	(1)		1.0					
Totals	13					5				

AREA E

	San Marcos					Round Rock				
Species	Lv. 1-2	(T)	(B)	MNI	1.0m³	3-11	(T)	(B)	MNI	1.0m³
Rabbit						7	(6)	(1)	1	7.0
Pocket Gopher						5	(4)	-	1	5.0
Cotton Rat						2	-	-	1	2.0
Wood Rat						1	(1)	-	1	1.0
Rodent						11	(7)	(1)		11.0
Small mam.						8	-	(1)		8.0
Medium mam.						1	-	-		1.0
Large cam.						-				
Snake Sp.						2	-	-		2.0
Viper						2	-	-		2.0
Coluber						2	-	-		2.0
Turtle Sp.						6	-	(4)		6.0
Pond Slider						1	-	-		1.0
Frog Sp.	1	-	-							
Totals	1					48				

(T) = No. of teeth included in total.
(B) = No. of burned elements included in total.
m^3 = Volume excavated and element density per taxon.

also suggest that the occupation of this culture group at 41WM73 was infrequent. The small amount of faunal remains from this component makes it osteologically incidental.

Features

Feature 1 is located at Area A in association with Round Rock material. The 4 fragments of bone recovered form this feature attest to the extrinsic nature of their presence. Only 1 element was identified from this feature, that being a tooth enamel fragment from a deer.

Feature 2 contained 171 bone fragments of which 55% (n = 94) are burned. This burned rock-lined pit also contained evidence suggestive of acorn parching but lacked burned earth indicative of hot fires. Whether the feature was additionally used to cook animal resources or secondarily as a refuse pit for food remains is troublesome. Most of the bones are charred brown (some turtle shell fragments are burned black), but none are burned white which would indicate a hot fire. Therefore, the lack of burned earth does not negate the possibility that the pit was used infrequently for cooking both animal and vegetable foods.

Twelve different taxa are identified from the feature material. Birds are the only vertebrate class not represented. Furthermore, deer remains are scant, similar to the pattern established for all of the components. Only a burned toe bone is identified as deer although a small tooth fragment may also be deer. Rodents and turtle are again the most prevalent animals identified.Table 15.7-20 lists the elements and species identified in this feature.

Site Summary

The components in Area B are most representative of the occupational remains of the culture groups frequenting 41WM73 in antiquity. Two components are especially important, Clear Fork and Round Rock. An intermediate zone between these 2 homogeneous components is designated as a composite of the two, and it is in the early part of the composite component that the midden is proposed to have originated.

The density of faunal remains in this composite zone is quite high and preservation is better than material found outside the midden associated with San Marcos artifacts. The midden was used quite probably as a trash dump for subsistence remains and was used frequently enough to rapidly bury material in the lower levels helping to preserve these bones in a relatively good state.

Identifiable small mammal remains outnumber large mammals in every component and rodents were undoubtedly utilized as a food source indicated

Table 15.7-20. Identified Vertebrate Remains from Feature 2, 41WM73

QUANTITY	ELEMENT	TAXA	STATE
4	Teeth	Cottontail rabbit	2 burned
2	Teeth	Pocket gopher	
1	Mandible	Cotton rat	
1	Tooth	Woodrat	
12	Incisors	Rodent	3 burned
1	Tibia	Rodent	burned
1	Ulna	Rodent	burned
1	I phalange	Deer	burned
1	Tooth Fragment	Large Mammal	
7	Shell Fragments	Turtle sp.	7 burned
1	Vertebra	Colubrid	
1	Vertebra	Viper	
1	Element	Frog sp.	
2	Vertebrae	Fish sp.	

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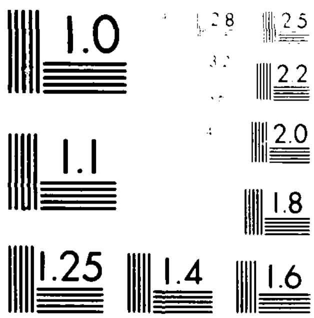

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by the abundance of burned rodent elements and consistent breakage patterns. The unidentifiable sample contains many large mammal size fragments, but they are disproportionate to the amount of smaller mammal remains.

Other vertebrate classes are present with evidence of greater utilization of fish, amphibians and birds in the earlier components. Reptile remains are primarily broken turtle shells which are often found burned.

Both woodland and grassland species are present as well as aquatic types. No change in exploitative preference is apparent except for 2 prairie species (ground squirrel and prairie chicken) in the Clear Fork component that do not appear in the later samples.

Site 41WM304

A total of 264 bone fragments were removed from 2 excavations and backhoe material of which 11.7% (33) are identifiable. Three different components have been designated as Round Rock, Clear Fork and a pre-midden zone tentatively assigned to the San Geronimo phase. Area B has no Round Rock material. For bone totals by level and component see Appendix C.

The majority of the identified bone from this site are recent intrusives such as armadillo, goat, and probably cotton rat (Table 15.7-21) which all come from upper levels at both excavation areas. A bird pelvis fragment from Area B, level 1, also appears comparatively fresh and should be counted as intrusive.

Since one armadillo scute and rat humerus are the only identified fauna out of 18 bones recovered from the Round Rock levels, it is difficult to assess animal utilization for this phase at WM304; five of the 18 elements are burned, but etiology is unknown and may be fortuitous (i.e., grass fire).

Faunal remains are most numerous in the Clear Fork levels at both areas: n = 94 at area A and n = 76 at area B. Burned bone is more abundant at area A although the variability between excavation areas is negligible. Identified aboriginal species from this phase are few, consisting only of rabbit (some burned) and a small burned tooth fragment from a medium to large-sized mammal. Again, the sample is too small for adequate analysis.

The pre-midden zone (San Geronimo ?) also yeilded only a small amount of bone (68 fragments), but over half are burned. Rabbit, rodent and turtle are present; the turtle fragments is the only identified bone that is unburned. A burned astragulus from a large rodent (cf. woodrat, pocket gopher, ground squirrel in size) and 2 burned rabbit elements suggests a temporary campsite where foraging produced small animals for meals.

Table 15.7-21. Total Number of Elements by Vertical Provenience, Site 41WM304

AREA A

SPECIES	ROUND ROCK 1 - 4	(T)	(B)	CLEAR FORK 5 - 7	(T)	(B)	
Armadillo	1	-	-				
Rabbit				3	(2)	(1)	
Cottonrat	1	-	-				
Large mam.				1	(1)	(1)	
TOTAL ID	2			4			

AREA B

SPECIES		CLEAR FORK 1 - 6	(T)	(B)	PRE-MIDDEN 7 - 9	(T)	(B)
Armadillo		17	-	-			
Rabbit					2	(1)	(2)
Goat		1	(1)	-			
Rodent					2	(1)	(1)
Bird sp.		1	-	-			
Turtle sp.					1	-	-
TOTAL ID		19			5		

The only identified deer elements recovered at this site come from the backhoe trench. However, an intriguing fragment was removed from the pre-midden zone (Area B). It is approximately 3 cm long, burned gray and white with a tinge of blue and is probably a long bone shaft fragment of a deer-sized mammal. The marrow cavity appears small in circumference, but the bone wall is 5 mm thick on one edge and 8 mm thick on the other. It has several triangular nicks on the outer surface and two light, almost parallel cuts next to the nicks. The edges are very irregularly broken unlike the smooth edges produced by spiral fractures. It is the only fragment from this assemblage with a hint of alteration by man if burning discounted. Furthermore, unlike the rest of the recovered bone here, this fragment does not exhibit the typical pitting and attrition seen on burned and unburned pieces.

Preservation of aboriginal bone is very poor; most of the fragments are quite small, very pitted and eroded, suggesting that they may have passed through a digestive system (human or animal) prior to deposition. However, larger fragments (i.e., deer) from the backhoe material are similarly pitted and poorly preserved.

Site 41WM328

Two excavation areas and 2 backhoe trenches yielded a total of 818 bone fragments of which 7.4% (61) are identifiable (Appendix C). Remains of deer and cottontail indicate them as the primary species recovered. Only one non-dental element of rabbit was found in all the material. Beaver, dog, jackrabbit and turkey are represented by one or two elements each (Table 15.7-22). Of non-mammalian fauna, fish are noticeably important at Area A. Evidence of burned catfish and deer come from the hearth area in Feature 8. Burned turtle shell fragments are also found in Area A, although not associated with any hearths. Area B has more deer and rabbit elements but no fish. The only dog element recovered is a burned proximal metatarsal fragment (also from Area B, level 14). A burned caudal vertebra fragment found in level 18 of Area B is of medium mammal size and may be dog as well.

Vertically the site is dominated by levels associated [illegible] ne Twin Sisters phase (levels 2-7 at Area A and levels 14-21 a[illegible]), and Area B also contained an Austin component (levels 8-10). The upper levels of Area B were nearly sterile of bone with only 4 fragments (3 are burned) all found in level 4. An unburned turtle shell is the only identified fragment. Turkey is the only identified species found in the Austin levels that is not found in the Twin Sisters levels. A beaver tooth is found in the Austin component and another comes from level 4 (Twin Sisters) of Area A. Fragments of an unburned deer maxilla were removed from backhoe material; the tooth wear suggests a middle-aged adult at death.

Table 15.7-22. Total Number of Elements by Vertical Provenience, Site 41WM328

AREA A

SPECIES	UNKNOWN 1	(T)	(B)		TWIN SISTERS 2 - 7	(T)	(B)
Rabbit	None Identified				1	(1)	-
Pocket gopher					1	(1)	-
Beaver					1	(1)	-
Deer					9	(2)	(8)
Rodent					1	(1)	-
Turtle sp.					5	-	(4)
Fish sp.					1	-	(1)
Catfish					3	-	(2)
TOTAL ID					22		

AREA B

SPECIES	UNKNOWN 1 - 7	(T)	(B)	AUSTIN 8 - 10	(T)	(B)	TWIN SISTERS 14-21	(T)	(B)
Rabbit				3	(2)	(1)	2	(2)	(1)
Jackrabbit							1	-	(1)
Beaver				1	(1)	-			
Dog sp.							1	-	(1)
Deer				3	(2)	-	21	-	(21)
Rodent							1	-	(1)
Medium mam.							1	-	(1)
Turkey				1	-	(1)			
Snake sp.							1	-	-
Turtle sp.	1	-	-						
TOTAL ID	1			8			28		

(T) = No. of teeth included in total
(B) = No. of burned elements included in total
m^3 = Volume excavated and element density per taxon

Preservation at this site is fairly good for unburned bone. However, 75% of the bones are burned, thereby reducing the chances for accurate identification for most elements. This much burned bone can be expected from a small site where 17 hearths were excavated. Eleven hearths contained bone and only three of these hearths yielded any identifiable bone (F-8 at Area A and F-15 and F-17 at Area B). A total of 96 bone fragments come from hearths and five are identifiable as deer, snake, rodent and catfish; all but one fragment are burned. The majority of unidentifiable material from the hearths is fragmentary, burned remains of large mammals, most likely deer since this species is most common among the identified bone.

Based on the abundance of hearths and considering that most of the elements recovered at this site are non-meaty, the site probably functioned both as a butchering and cooking area. Remains of meals must have been carefully removed or thoroughly masticated by dogs and scavengers. It is unlikely that bone butter was manufactured at the site because most of the unidentifiable splinters are quite burned as if directly placed on the coals.

Site 41WM404

Brown Tick Shelter is one of two rock shelters in the study area and the only one to be excavated during this project. The fauna from this site is also distinctive and several new species were added to the comprehensive list when these materials were analyzed. For example, no other site contained elements identified as prairie dog, gray fox, or goat. The goat bones are undoubtedly intrusive, as goats are currently pastured nearby. Two bird species are also unique to this sample--vulture and spoonbill or wood stork (family Ciconiidae). The singularity of occurrence of these animals is probably the result of differential preservation. The deposits in rock shelters are not as vulnerable to percolating water, therefore, minimizing the damaging effects of wet-dry cycles. With better preservation, greater identifiability is expected.

Fifteen percent of the total bone recovered (652/4,382) is identifiable to some degree (Table 15.7-23). This is not a particularly high site percentage, however. For example, the overall percentage of identified fauna from 41WM73 is 20% and two sites in the Granger reservoir exceed 15%. Other factors must have operated to diminish the indentifiability of the faunal remains in the rock shelter. As in the upper deposits occurred after each occupation which is possibly attributable to scavengers. These scavengers would remove certain refuse and cause extensive breakage by gnawing, thereby impairing later identification of osseous items.

The list of identified species (Table 15.7-24) is divided into two groups, the Neo-American or upper levels and the mixed Archaic or lower levels

Table 15.7-23. Faunal Summary for 41WM404

COMPONENT	NEO-AMERICAN	ARCHAIC
Vol. m^3	.5	.5
TOTAL BONE	3,166	1,216
DENSITY/m^3	6,332	2,432
# ID	530	122
% ID	16.74	10.03
MAMMALS	*82%*	*86%*
BIRDS	*6%*	*1%*
REPTILES	*11%*	*13%*
AMPHIBIANS	*1%*	-
FISHES	-	-
TOTAL % BURNED	39.73	56.08
ID % BURNED	13.58	18.85

Table 15.7-24. Number of Faunal Elements by Component for Brown Tick Shelter, 41WM404.

SPECIES	NEO-AMERICAN n	(T)*	(B)†	%	ARCHAIC n	(T)*	(B)†	%
Opossum	3	-	-	1	-	-	-	-
Armadillo	86	-	-	17	1	-	-	2
Rabbit	85	(1)	(3)	16	2	-	(2)	3
Jackrabbit	1	-	-	1	2	-	-	3
Fox Squirrel	7	(1)	-	2	1	-	(1)	2
Prairie Dog	2	-	-	1	-	-	-	-
Cotton Rat	3	-	(1)	1	-	-	-	-
Woodrat	21	-	(1)	4	-	-	-	-
Beaver	7	(5)	(2)	2	-	-	-	-
Raccoon	7	(4)	-	2	3	(1)	(1)	4
Skunk	2	-	-	1	-	-	-	-
Gray Fox	1	-	-	1	-	-	-	-
Dog/Coyote	7	(3)	(2)	2	3	(2)	-	4
Deer	169	(44)	(41)	32	37	(1)	(11)	44
Goat	13	(3)	-	3	4	(1)	-	5
Artiodactyla	4	-	-	1	2	-	-	3
Cow/Bison	9	(2)	(3)	2	-	-	-	-
Elements: rodent	1	-	-	1	-	-	-	-
-Small	3	-	(1)	1	1	-	-	2
-Medium	15	(2)	(4)	3	10	(7)	(2)	12
-Large	5	-	(1)	1	8	(4)	-	10
Bird sp. medium	2	-	-	1	-	-	-	-
Bird sp. large	4	-	-	1	-	-	-	-
Turkey	11	-	1	2	1	-	-	2
Vulture	3	-	-	1	-	-	-	-
Prairie Chicken	1	-	-	1	-	-	-	-
Bobwhite	2	-	-	1	-	-	-	-
Owl sp.	1	-	-	1	-	-	-	-
cf. Spoonbill	2	-	-	1	-	-	-	-
cf. Hawk	1	-	-	1	-	-	-	-
Snake sp.	3	-	-	1	-	-	-	-
Viper	23	-	-	5	1	-	-	2
Coluber	2	-	-	1	-	-	-	-
Turtle sp.	12	-	(4)	3	9	-	(9)	11
Pond Slider	4	-	(1)	1	-	-	-	-
Musk/Mud Turtle	3	-	(2)	1	-	-	-	-
Frog sp.	1	-	-	1	-	-	-	-
Bullfrog	3	-	-	1	-	-	-	-
cf. Human	1	-	(1)	-	37	-	(1)	-

* teeth
† burned

The invisible line demarcating upper from lower levels varied between squares, but the upper levels consistently yielded more and varied faunas. For example, the upper levels have 38 different taxa whereas only 15 are specified for the lower levels. Even though some intrusives are obvious in the upper levels (e.g., armadillo and goat), the extent to which owls or other predators utilized the shelter after man and left their own food debris is indeterminable. The quantity of rodent and snake remains could be attributable to predatory birds except that one of the woodrat elements is burned and 23 viper vertebrae could easily represent only a single snake instead of multiple kills that would be expected from a roosting predatory bird.

The persistent problem with discerning intrusives is that each explanation is as plausible as another. For example, the prairie dog's current range is almost 200 miles west of this site and would constitute an excessive distance for a predatory bird or animal including aboriginal man. However, the gregarious rodents' range may have been much less distant in antiquity especially if drier times extended the short-grass prairies eastward. This eastward expansion of the prairie would have provided adequate habitat (in areas of sandy substrate) for this species allowing its exploitation by either animal or human predator.

The presence of prairie dog bones is even more important in that Lundelius (1965) records the disappearance of this rodent from certain parts of the Edward's Plateau coinciding with the end of the Wisconsin glaciation. He states,

> The prairie dog Cynomys ludovicianus is another species that had a more extensive distribution in central Texas during the Wisconsin. Although it is known historically from Mason, Sutton, and Schleicher counties, it has not been found in any of the post-Pleistocene faunas from other parts of the Plateau (Lundelius, 1965: 312).

He further asserts that "...the modern faunal composition of central Texas was attained about 1000 A.D." (1965: 312). Based on his dates, Davis' range maps and remains from Neo-American levels at Brown Tick Shelter, the following timetable for the presence of prairie dog emerges:

Wisconsin period--prairie dogs are widespread in Central Texas;
8000-6000 B.C.--prairie dogs disappear with end of Wisconsin;
1000 A.D.--faunal composition attained, prairie dogs are west of Williamson County;
750-1300 A.D.--prairie dog remains are identified in Neo-American contexts in Williamson County;
present--nearest county record of prairie dog in relation to Williamson County is Mason County approximately 100 miles west.

Clearly Lundelius is dealing with overall faunal changes for a large geographical area and great expanse of time. Unfortunately, he does not account for the presence or absence of prairie dogs between 6000 B.C. and 1000 A.D., so it is assumed that this species has been absent from most of Edward's Plateau since the end of the Wisconsin glaciation. Therefore, we must reconsider the rigidity imposed on species distributions and the causal factors for their distribution. In the case of prairie dog bones at Brown Tick Shelter (a post-Pleistocene site in the Edward's Plateau), it is quite possible that periodic drying trends extended the prairie and thus broaden the prairie dog's distribution. These short term climatic changes are indiscernable without reliable pollen information or sedimentation rates.

Other prairie species in the upper levels include jackrabbit and bison in relatively low numbers. Likewise bobwhite and prairie chicken remains are present in low densities. It is the woodland forms which dominate in contrast to the prairie types although the prairie was utilized occasionally. Woodland habitats surround the shelter. Old oaks found in the uplands today suggest the presence of a forested habitat above the shelter in antiquity. Furthermore, if the riparian zone below the shelter were left to natural succession, it too would be a wooded area that could adequately support the variety of faunas exhibited in this assemblage. The low incidence of prairie forms supports an inference that the grassland habitat was somewhat distant and infrequently exploited. Even the prairie species that tend to aggregate (quail, prairie dog and bison) might not be predictably present to warrant the energy output necessary to procure them. In contrast, exploitation of the riparian zone would ensure procurement of arboreal, aquatic and terrestrial game.

Birds are identified in great variety from the rock shelter material. Large birds such as turkeys, hawks, owls, and vultures are present in higher numbers than medium birds, and no bones from small birds were found. Turkey bones are the most abundant in the upper levels and the only bird to be found in the lower levels. One turkey element from one of the exterior squares (N100/W100) is the singular representative of avifauna recovered from Archaic levels. Turkey are present in the riparian woodlands of the area today.

Aquatic species are virtually absent in the Archaic levels. Some unspecific turtle shell fragments are noted from the outer and front regions of the shelter in the lower levels. By contrast, the Neo-American levels contain adequate quantities of frog, water turtle, and beaver remains. One beaver is indicated by 7 fragments (mostly teeth) of which 2 are burned. These were recovered from 4 squares along the front of the shelter although their association with possible features is not clear. Since only one individual is present, beaver was probably a special addition to the diet of the occupants.

Other medium-sized mammals are also incidental in the Neo-American sample. Raccoon, skunk, dog and fox are represented by only a few elements each although more elements may exist among the unidentifiable sample. Further, no more than one individual is represented for each based on the recovered elements. In general, medium mammals are not well represented in prehistoric sites in Texas perhaps because most are secretive and difficult to catch or lack local abundance. Skunk and raccoon were probably abundant in the area as they are today but may not have been worth the energy expenditure except when deer were unavailable.

As indicated in Table 15.7-24, the bulk of the aboriginal diet was composed of deer which comprises 32% of the identified sample from Neo-American levels and 44% of the Archaic sample. Frequency for deer is lower for the Neo-American levels principally because species diversity is greater. The minimum number of deer, however, is greater in the Neo-American (MNI = 4), whereas 2 deer are represented in the Archaic sample. The deer elements from both zones come from several age groups including fawns, sub-adults and old adults. The range of ages indicate no preference by either group of hunters, and because young deer are present, a late summer/fall occupation is possible.

Horizontal distribution of elements in a contained site such as a rock shelter may give further clues to subsistence habits. For example, 75% of the deer bones from Archaic levels are found in front of the shelter in squares A, B, C, and D (Figure 15.7-1). Square C had the greatest concentration of deer elements and total bone for the Archaic zone. Square H and D also had heavy bone concentrations of which most are burned. In fact 56% of the total bone from the lower levels is burned compared to 39.7% of the upper level bone. Although no hearth features were located, burned bone preponderates in the lower level assemblage (682 burned: 534 unburned).

In contrast, the upper level assemblage contains more unburned bone. As a whole, the Neo-American sample is concentrated towards the back of the shelter. The highest unit concentrations, however, come from squares L and K which exceed 400 fragments each. Similarly identifiable deer elements abound in these squares but are even more concentrated along the back wall in squares R, P, and N (Fig 15.7-1).

Additionally, bison-sized fragments were also recovered in squares L, K, and P. One very large element (a metacarpal fragment) was recovered from the surface and should probably be considered modern cow. The large fragments from the units, on the other hand, are in good association with prehistoric artifacts. Two fragments are burned indicating some aboriginal use of bison although deer was surely the staple subsistence item.

The identified deer elements consist primarily of non-meaty elements: teeth, antler fragments, phalanges, and metapodials. Very few meaty limb

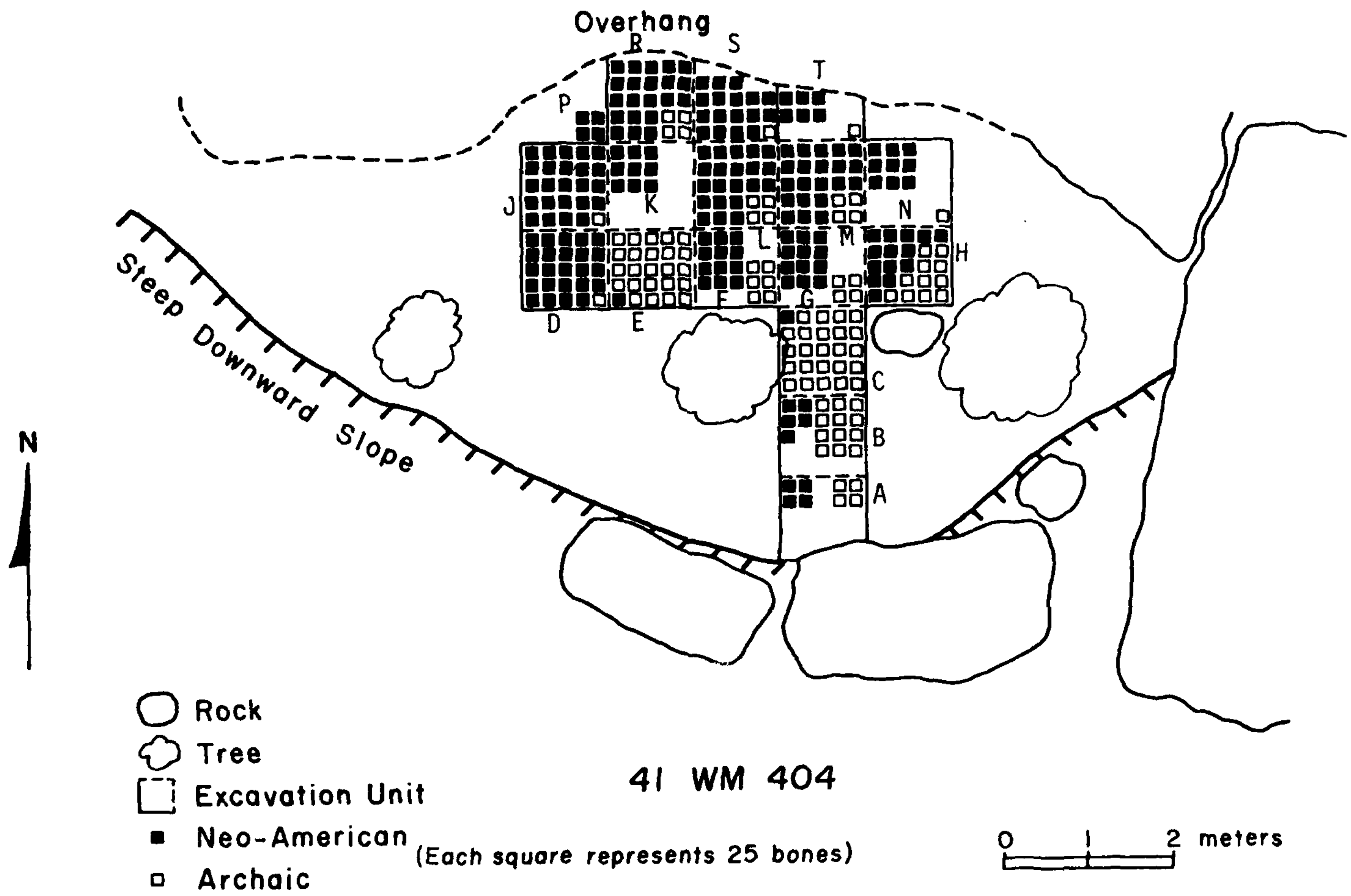


Figure 15.7-1. Distribution and Relative Density of Vertebrate Remains, 41WM404

elements were recovered intact enough for identification. Having been fragmented for marrow extraction, these underrepresented elements are likely present in the unidentified samples from both cultural components.

Interestingly, modified bone fragments are also located in squares with high concentrations of deer bone. They are described elsewhere in this volume. Associations with lithic tools have not been determined.

Summary

Brown Tick Shelter contains two broad cultural components containing occupational debris that differ substantially in composition and distribution. The lower or Archaic levels show evidence of utilization of very few different species whereas the upper levels or Neo-American component contains remains from 38 taxa. Spatially the Archaic material was located near the edge of the terrace in front of the shelter which would be expected from rock shelters where earlier material washes down the talus slope. In this case, however, there is little slope (Figure 12.20-3). Furthermore, Archaic materials are found in the far rear of the shelter indicating little structural change in the depth of the shelter between Archaic and Neo-American occupations. Conversely, very little bone associated with Neo-American materials occurs out front but is quite dense in the eastern section and in the rear. This contrast in horizontal distribution suggests many possible interpretations.

First of all, the natural condition of the shelter must be considered. The loose, non-alluvial soil lends itself easily to the disturbance of cultural debris and therefore allows the mixture of faunal remains vertically as well as horizontally. Furthermore, scavengers and human visitors displace these materials when they move about the shelter. Because of these factors, the remains found by the archaeologists may have been completely rearranged and thus impair accurate cultural inferences. Erosional factors undoubtedly played a part as well.

Secondly, the original overhang may have prehistorically extended 1 or 2 meters beyond the current drip line. No one can say when the boulders on the slope broke away from the shelter. If the shelter extended farther, then the activity centers inside the shelter may have been further out on the ledge. This assumption creates new inferences regarding the distribution and disparity between the two components.

For example, the Archaic groups may have occupied the shelter for longer periods and discarded their food refuse down the slope. This along with the possibility that subsequent occupations (by other Archaic groups or later Neo-American groups) cleared the surface when they set up living quarters, would account for the low densities of bone for the Archaic levels. On the other hand, the Neo-American levels have twice the density of bone, and the remains are concentrated inside the shelter. This generates the question of why would these people litter their living

quarters with butchered bones and risk attracting carnivores. Without attaching current cultural aversions, it seems safe to also assert that most human groups actively avoid fouling their quarters. Therefore, it is plausible to infer that the Neo-American groups utilized the shelter as either (1) a protected butchering area (based on the abundance of non-meaty elements) or (2) an intensively used temporary campsite (recurrent occupations of short durations and little subsequent "house cleaning"). Because of severe interfusion and lack of features, reliable interpretations about the lifestyles of these groups are difficult.

As mentioned in the archaeological report, human remains were recovered in front of the shelter. Several elements of an infant were found in square C levels 5 and 6. These bones were not recognized as human in the field and no indication of a feature was recorded. The remains are listed with the Archaic material although it is quite likely that the child constitutes a Neo-American burial.

An enigmatic burned bone from level 2 of square J appears human in morphology and surface texture. It is burned black and lacks both diagnostic articular surfaces. However, the remaining diaphysis conforms well to an immature V metacarpus of a human left hand. No other bone fragments (burned or unburned) from this unit appear to be human. The presence of this element remains unexplained.

Vertebrate Faunal Remains from Granger Reservoir Excavations

Site 41WM124

The Bryan Fox Site yielded approximately 3,000 pieces of bone, 2,951 from 3 excavation areas and 138 from 6 trenched areas. Sixteen percent of the osteological material is identifiable, and mammals and reptiles are the most frequently identified vertebrate classes (Table 15.7-25). Condition of the bones is generally good. Preservation can be attributed to rather rapid deposition as determined by the excavators. Few bones are burned, in fact, less than 10% of the bones from Area C exhibit burning.

Area C contains the earliest material and has been designated as a Clear Fork component. It is a shallow gully site yielding 309 pieces of bone. Identified faunal material comes only from levels 2, 3, and 4. These levels are quite dense for artifacts as well.

Downslope from Area C and about 100 meters away are Areas A and B. Both have delineated San Marcos and Twin Sisters components covered by comingled material from Austin and Toyah occupations. The alluvial deposits at Area A descend 37 levels (3.7 m) with very thick cultural lenses of San Marcos and Twin Sisters debris (2.9 m^3 and 2.6 m^3 respectively). Area B at the terrace edge contained 22 levels in which the volume for the San Marcos component was 2.0 m^3 and 1.4 m^3 for the Twin Sisters component. Little artifact mixture occurred between components at either excavation area.

Clear Fork

The faunal material associated with the Clear Fork component at Area C is composed of all vertebrate classes except Amphibia. As the table indicates, only 309 fragments were recovered of which 21% are identifiable. Preservation is fair and very few bones are burned. No identified bones are burned. Density is 280 fragments per cubic meter (Table 15.7-26).

Mammal remains, primarily deer, outnumber the other classes, but these are highly fragmented elements. Only two deer limb elements are present and the remainder is composed of non-meaty remains such as teeth, feet, and vertebrae. No butchering marks are apparent on these few elements. At least two deer are represented by adult and deciduous teeth and fused and unfused vertebrae.

TABLE 15.7-25. Faunal Summary for 41WM124

COMPONENT	AUSTIN/TOYAH	TWIN SISTERS	SAN MARCOS	CLEAR FORK
AREAS	A Lv 1-5 B Lv 1-7	A Lv 6-20 B Lv 8-12	A Lv 21-37 B Lv 13-22	C all Lv 1-6
Vol. m^3	2.4	4.0	4.9	1.1
TOTAL BONE	223	1453	966	309
DENSITY/m^3	93	363	197	280
# ID	20+ (27=Armadillo)	266	100+ (2=Arma.)	64
% ID	9.0	18.3	10.4	21
MAMMALS	65%	64.3%	68.8%	67.2%
BIRDS	5%	1.5%	--	12.5%
REPTILES	25%	32.3%	31.3%	18.8%
AMPHIBIANS	--	1.1%	--	--
FISHES	5%	.8%	--	1.6%
TOTAL % BURNED	29	20	21	8.7
ID % BURNED	0	10	10	0

Table 15.7-26. Total Number of Elements by Vertical Provenience, Site 41WM124

Area C.

SPECIES	CLEAR FORK all	(T)	(B)	MNI	1.1m^3
Rabbit	4	-	-	1	3.63
Jackrabbit	9	(3)	-	1	8.18
Beaver	2	(1)	-	1	1.81
Raccoon					
Badger	1	-	-	1	.90
Deer	26	(8)	-	2	23.63
Snake sp.	1	-	-		.90
Viper	8	-	-		7.27
Colubrid	2	-	-		1.81
Yellow mud turtle	2	-	-		1.81
Fish sp.	1	-	-		.90
Bird sp. medium	2	-	-		1.81
Prairie Chicken	6	-	-	2	5.45
TOTAL ID	64				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

Remains of an adult jackrabbit were recovered from a single quad in level 3, and elements of at least one cottontail rabbit also come from that quad, but one level lower. The breakage pattern on the humerus and tibia of the cottontail is similar to that seen in other Clear Fork components in both reservoirs.

Evidence of beaver and badger is also present indicating use of riparian and prairie biomes. The site location is adequate for hunting in either habitat because of proximity to water and to the uplands where conditions were zeric enough for badger and jackrabbit.

Prairie chicken is well represented in the sample adding evidence for localized grassland prairie vegetation zone. Two individuals are represented by two right and two left coracoids which are all broken in approximately the same places.

Reptile remains rank second in frequency. Eleven snake vertebrae represent at least two different species, a colubrid (cf. Natrix sp.) and a viper, which may be a cottonmouth. Both of these species suggest proximity to water and so do the turtle remains. Parts of the carapace and plastron from a yellow mud turtle (Kinosternon flavescens) are identified in levels 3 and 4. This reptile prefers sandy or muddy bottomed waterways where it is active 140 days of the year, hibernating in shallow natural depressions during cold weather (Ernst and Barbour, 1972; Mahmoud, 1969).

Fish utilization is represented by a single vertebra (cf. Catfish sp.) measuring 5 mm in diameter. It was recovered from level 3 and attests to the presence of running water near the Clear Fork occupant's camp.

San Marcos

The density of faunal remains (197 fragments per cubic meter) in the San Marcos component is lower than that of Clear Fork and Twin Sisters and species diversity is also lower. Only 13 taxa are recognized in the identifiable sample which is only 10% of the bone recovered in this component.

Mammals and reptiles are the only vertebrate classes involved. Most of the mammalian remains are small fragments of deer elements and some rabbit and rodent elements (Table 15.7-E). Pocket gopher, cotton rat and a species of white-footed mouse (Peromyscus sp.) are identified mostly from Area A. They are likely intrusive since none is burned nor found in feature material.

Deer bones are highly fragmented and constitute 46% of the identified sample. The same types of body parts are found at both excavation areas. However, those at Area B are more fragmented and deteriorated than at

Area A, and fewer are burned. With one exception, the deer elements are from non-meaty parts of the body: teeth, cranium, vertebrae, and feet. A small distal humerus fragment is the only identified limb among the elements from Area A and may be from a sub-adult. Two individuals are represented by fused and unfused vertebral epiphyseals, adult phalanges, and deciduous teeth.

Some larger teeth enamel fragments were recovered from a quad at level 30 that may be from bison. However, no fragments from animals larger than deer were securely identified.

Snake and turtle remains were also recovered, but they represent only 1 or 2 individuals. One small colubird snake vertebra is burned, but none of the turtle shell fragments (probably box turtle) show evidence of fire.

The small amount of deer remains and the elements present in conjunction with the archaeological information substantiate the conclusion that the San Marcos component in the investigated portion of the site represents a series of ephemeral occupations.

Twin Sisters

Although slightly less in volume, this component yielded bone in almost twice the density (363 fragments per cubic meter) as that in the San Marcos component. Species diversity is moderate with 25 taxa in the identified sample. A little over 18% of the total bone from this component is identifiable. Birds and fishes are minimally represented in the material, and this is the only component containing evidence of amphibians. Mammals and reptiles expectedly dominate the sample.

Deer, rabbit, and rodents (especially pocket gopher) are the most frequently identified mammals (Table 15.7-D). Beaver and raccoon are minimally represented and suggest continued utilization of the riparian locale near the site. Although jackrabbit remains were recovered, faunal evidence suggests that the upland prairie contributed little to the subsistence of the site's occupants (Table 15.7-27).

Two individual deer are represented by fused and unfused vertebrae and worn teeth, from an old adult, along with some deciduous teeth. The other elements are from non-meaty elements similar in kind to those found in other components. Many of the limb elements may be present as indistinguishable fragments among the unidentified sample. Some lower leg and feet bones are burned as well as one antler fragment. Four elements have obvious butchering marks which include two small parallel cuts on the anterior ridge of a right calcaneum, two deeply notched areas on both a metatarsal shaft fragment and a burned proximal metacarpal fragment, and a large hole in the side of a charred first phalanx possibly made to extract marrow. Bone tools were found in this component and are discussed elsewhere in this volume.

Table 15.7-27. Total Number of Elements by Vertical Provenience, Site 41WM124.

Area A

SPECIES Lv.	AUSTIN/TOYAH 1-5	(T)	(B)	MNI	1.4m³	TWIN SISTERS 6-20	(T)	(B)	MNI	2.6m³	SAN MARCOS 21-36	(T)	(B)	MNI	2.9m³
Opossum						2	(1)		1	.76		-	-	1	
Rabbit						11	(3)	(1)	2	4.23	4				1.38
Jackrabbit						9	(4)	(1)	2	3.46					
Pocket Gopher						13	(4)	-	2	5.00	3	-	-	2	1.03
Vole						4	(2)	-	1	2.30					
Deer Mouse						1		(1)	1	.38	1	-	-	1	.35
Cotton Rat	1	-	-	1	.71	2	-	-	1	.76	2	-	-	2	.69
Woodrat						1	-	-	1	.38					
Beaver						1	(1)	(1)	1	1.54					
Armadillo	27	-	-	1	19.30						2	-	-	1	.69
Deer	4	(3)	-	1	2.90	91	(49)	(11)	1	34.61	39	(7)	(8)	2	13.45
Rodent						15	(5)	(1)		3.46	4	-	-		1.38
Small mam.						1	-	(1)		.38	1	-	-		.35
Medium mam.						7	(1)	(1)		2.70	1	-	-		.35
Large mam.						3	(6)	-		1.15	1	-	-		.35
Cow/Bison											4	(4)	-	1	1.38
Bird sp. small						1	-			.38					
Bird sp. medium						2	-	(1)		.76					
Turkey						1	-	-		.38					
Snake sp.	1	-	-		.71	19	-	(4)		7.31	2	-	-		.70
Viper						23	-	(1)		8.85	4	-	-		1.38
Colubrid						22	-	(1)		8.46	7	-	(1)		2.41
Hog-nosed Snake						1	-	-		.38					
Lizard sp.						1	-	-		.38					
Salamander sp.						1	-	-		.38					
Frog sp.						2	-	(1)		.76					
Turtle sp.	2	-	-		1.43	17+		(1)		6.92	12	-	-		4.14
Yellow mud turtle						1	-	-		.38					
Fish sp.						1	-	-		.38					
Gar sp.						1	-	(1)		.38					
TOTAL ID	35					259					87				

(T)= No. of teeth included in total. (B)= No. of burned elements included in total. m³=Volume excavated and element density per taxon.

The frequency of reptiles is high because of fragmentation of turtle shells and snake vertebrae. Therefore, their contribution to the subsistance of the site's occupants should not be overestimated. Since elements from each herptile taxon are burned, we can assume that they supplemented the diet. The exact species of snake is conjectural, but some, more complete colubrid vertebrae show affinities with water snake species (Natrix), and at least one turtle plastron element is identified as yellow mud turtle (K. flavescens) indicating more evidence of aquatic utilization in the Twin Sisters component. Frog and salamander remains further substantiate this utilization. However, fish remains are not as prevalent as in Clear Fork or Neo-American components. Fish are found exclusively in Feature 1 of this component.

Frequency of birds is also lower than in the earliest and later periods. However, the diversity seems greater. At least three different species of bird are recognized, but only turkey is identified by element. Turkey would have been available in the same habitat as opossum and deer (oak woodlands) and probably easier to obtain during their breeding season which in Texas begins in February (Schorger, 1966).

Feature 1 added several species (e.g., vole, turkey, gar) to the faunal list for this component. It is discussed following the Neo-American component.

Neo-American

A mixture of Austin and Toyah projectile points render these levels unsegregational. The faunal assemblage for this component is very low in density (23 fragments per cubic meter) with a total of 2.4 m^3 assigned as an Austin/Toyah amalgam. Of 223 bones recovered, 21% are identifiable. However, 27 of those 47 identified are armadillo scutes and therefore intrusive.

Of the remainder, the greater concentration of archaeological fauna comes from Area B (Table 15.7-28). Identified bones (from either excavation unit) are burned although Area B ahd more burned fragments in general. The absence of hearth type features at this unit suggests transient usage of the site.

Species diversity is low (12 taxa) but relatively higher than that expected considering the paucity of total bone. Very little deer bone (three fragmented elements and five loose teeth) suggest the possibility that even this species might be accidental. Only one identified element is recorded for each of the other species, excluding turtle and deer (Table 15.7-C). Therefore, few inferences regarding subsistence can be made.

Table 15.7-28. Total Number of Elements by Vertical Provenience, Site 41WM124.

Area B.

	AUSTIN/TOYAH					TWIN SISTERS					SAN MARCOS				
SPECIES Lv.	1 - 7	(T)	(B)	MNI	1.0m³	8 -12	(T)	(B)	MNI	1.4m³	13-22	(T)	(B)	MNI	2.0m³
Rabbit	1	-	-	1	1.0										
Ground Squirrel	1	-	-	1	1.0										
Pocket Gopher	1	-	-	1	1.0						1	(1)	-	1	.50
Beaver	1	-	-	1	1.0										
Cotton Rat						1	-	-	1	.71					
Raccoon						1	(1)	-	1	.71					
Rodent															
Small mam.											1	-	-		.50
Medium mam.															
Large mam.											1	-	-		.50
Deer	4	(2)	-	1	4.0	4	-	-	1	2.85	7	(1)	(1)	1	3.50
Snake sp.															
Viper	1		-		1.0						1	-	-		.50
Colubrid						1	-	-		.71	2	-	-		1.00
Turtle sp.	1	-	-		1.0						2	-	-		1.00
Fish sp.	1	-	-		1.0										
Bird sp.															
Prairie Chicken	1	-	-		1.0										
TOTAL ID	12					7					15				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

Two species not found in the other components at Bryan Fox indicate either increasing aridity or a preference for the prairie resources during Neo-American times. These are ground squirrel and prairie chicken. Otherwise, ground squirrel has been found only at Cervenka, 41WM267.

This small faunal sample from 41WM124 represents either (1) incidental usage of the site by both Austin and Toyah groups, (2) a single brief occupation by a transitional group, or (3) location of scavenger/domestic dog debris within an accumulation of lithic artifacts.

Features

Feature 1, a fire pit originating from level 22 in Area A, was first located at level 19 and is associated with the Twin Sisters component. With the aid of fine screening, a total of 266 bone fragments were removed from the feature fill mostly from levels 19 and 20. Only 18% of the total feature bone is burned. The function of the hearth is puzzling because in a repeatedly used cooking hearth where bones from previous meals would have been thrown back into the pit, more thoroughly burned fragments should be recovered. Considering the scant amount of burned bone in the lowest level of the hearth, perhaps the fire pit served some other purpose. Subsequently some activity requiring a hot fire resulted in burned rock and soil in the upper levels. Finally, it may have functioned as a place to bury either animal-processing debris or even ceremonial material.

The composition of species and their elements is what makes this feature intriguing. These animals and identified elements (Table 15.7-29) are unexpected as routine food although they are not unusual as supplements. A turkey foot bone and three fragmented deer teeth represent animals larger than a jackrabbit. The majority (53%, or 33 elements out of 62) are identified as rodents or lagomorphs and the rest are snakes, a small bird, a lizard, a salamander, a gar, and a small fish. Only three of these elements are limb bones and the remainder is composed of loose teeth, vertebrae, and feet bones. Furthermore, only two identified elements from this feature are burned: a deer mouse femur and a snake vertebra.

There are at least three possible origins for this collection of small animal remains: (1) rodent or snake activity, (2) burial of ritualistic or shamanistic articles, or (3) natural post-flooding deposition. No indication of burrowing activity was noted during excavations. Ethnographic information regarding medicine bundles cites possible contents as collections of many diverse articles of unknown utility. Some bundles contain recognizable "tools" of stone or bone as well as natural objects such as mummified birds of lizard and snake skins. These skins could retain traces of feet bones or even vertebrae (caudal), and tiny delicate skulls would leave teeth and cranial elements. Furthermore, no complete skeletons were recovered to suggest that these animals might represent either intrusives or deliberate burials, nor were any complete projectile points recovered. Two broken points were found in this feature, but there

TABLE 15.7-29. IDENTIFIED FEATURE BONE BY LEVEL, Site 41WM124

FEATURE 1	ELEMENT	TAXA*	QUANTITY
Level 19	long bone (humerus)	Lizard	1
	astragalus	Turkey	1
	tooth	Vole	1
	maxilla	Rodent	1
	rib	Snake	1
	ulna	Pocket gopher	1 (R)
	femur	Deermouse	1 (R) B
	astragalus	Rodent	1
	phalanx (2nd)	Rodent	1
	phalanx (3rd)	Rodent	1
	incisor	Rodent	1
	teeth (fragments)	Deer	3
	vertebrae	Snake (2 sp? + 2 viper)	4
	vertebra	Gar	1
	vertebra	Fish sp.	1
	tibiotarsus	cf. Fringillidae (small bird)	1
Level 20	vertebrae	Snake	7 (1 B)
	vertebrae	Snake	2
	tooth	Vole	1
	astragalus	Jackrabbit	1
	incisor	Cottontail	1
	incisor	Rodent	2
	femur	Cotton rat	1 (R)
	rib	Snake	1
	vertebra (atlas)	Rodent	1
	metapodial	Cottontail	1
	phlange (2nd)	Rodent	3
	phlange (3rd)	Rodent	2
	vertebra	Salamander	1
	pelvis fragment	Rodent	1
Level 21	vertebrae	Snake (2 viper)	2
	premaxilla	Pocket gopher	1
	mandible	Vole	1 (R)
	teeth	Vole	2
	incisor	Pocket gopher	1
	incisor	Rodent	1
	teeth	Pocket gopher	3
	maxilla fragments	Pocket gopher	1
	vertebrae	Snake sp.	3
	mandible	Vole	1 (L)
		TOTAL	62

*Total Elements by Taxa:

2 Cottontail	3 Deer (3 teeth)	4 Colubrid
1 Jackrabbit	15 Rodent	1 Lizard
7 Pocket gopher	1 Turkey	1 Salamander
1 Deer mouse (burned)	1 cf. Fringillidae	1 Fish sp.
1 Cottonrat	11 Snake sp.	1 Gar
6 Vole	5 Viper	B= burned

is no clear evidence supporting this assemblage as the remains of a medicine bag. Of these three possible origins, the one by natural means seems the least objectionable yet again just as difficult to verify. Small carcasses would be easily disturbed and dispersed during flooding where they could be deposited in a protected depression such as an abandoned hearth basin or pit. However, other evidence of leveling (i.e., washed out charcoal, soil bonding, other areal intrusives) makes the last conjecture improbable.

Feature 2 was located nearby in the wall of backhoe trench 6. Bones were noticed and recorded in the field although no osteological material was indicated as feature bone when submitted for analysis. Thirty-two elements out of a total of 76 fragments were removed from the trench and identified. They are mostly deer, although evidence of raccoon and beaver are also present. Two elements, an unfused metacarpal and a fragment of a tooth socket, compare well with bear (cf. Ursus americanus). Unfortunately, the relationship of these bones and Feature 2 is not clear. No fill was fine screened from this trench.

Summary

Three excavation areas at the Bryan Fox site give a brief glimpse at the subsistence of four culture groups. The Clear Fork occupants near the gully (Area C) stayed briefly and utilized the nearby waterway, which must have carried substantially more water then. Area A and B upslope at the terrace edge of the current river channel provided brief camping facilities--first for San Marcos people and then, for supposedly longer duration, Twin Sisters culture. The Twin Sister component left a couple of features, notably a fire pit, containing mostly unburned elements from very small creatures generally considered inconsequential to a diet of any large group of people, and possibly representing a cache of shamanistic or naturally deposited items.

The difference in faunal composition between the San Marcos and Twin Sisters components are apparent in both quantity and kind. Density of bone is almost twice as great in the Twin Sisters components where all vertebrate classes are present. Conversely, only mammals and reptiles are identified in the San Marcos assemblage. Riverine animals are more prevalent in Twin Sisters material, and tenuous evidence of bison is found only in the San Marcos levels.

The fourth component represents a mingling of two Neo-American artifact groups, Austin and Toyah. The faunal assemblage here is also found in Areas A and B but seemingly concentrated at the latter. The sample is quite small containing a number of intrusives and accidentals suggesting only the briefest occupation by these people(s) or extensive disturbance by modern agriculturalists resulting in loss of provenience.

Site 41WM163

Located on a small terrace, this partially disturbed site lies approximately 35 meters west of a branch of the San Gabriel River (see Reservoir map). Test trenches and excavation units yielded less than 500 bone fragments all from ¼" dry screening methods. Since no fine screen or flotation samples were processed, the 50 identifiable fragments are limited primarily to large mammal elements, deer and bison. Small fish, bird and turtle elements common to riparian sites are generally missed if fine screening is omitted. Besides deer and bison, other taxa include one element from a pocket gopher, a nonpoisonous snake vertebra and a piece of turtle shell.

These small animal remains all come from the levels associated with the Round Rock component from Area B which comprises the lowest levels excavated at the site. This component yielded the highest percentage identified bone, 38% (22/58). Elements from two individual deer, a fawn and an old adult, are the most numerous identified osteological remains of any taxa. The unidentifiable fragments are probably long bone remnants of marrow extraction activities as indicated by a high frequency of spirally fractured pieces. Although evidence of bison was recovered from a later component, none of the unidentifiable long bone fragments from this component appears massive enough for bison.

The only bison element in the San Marcos component is an incisor. The few deer elements indicate one adult individual. No other taxa were identified, but all 59 fragments are from large mammals.

A Twin Sisters component was located in levels 3 through 8 of Area B and yielded more bone fragments than any other component. Even when density is computed, this component still ranks highest with 199 fragments per cubic meter. Identifiable elements are surprisingly scarce. Three per cent or four elements were identified, all as deer. These are very fragmentary and consist of two teeth fragments and two feet elements.

Toyah material originated in the uppermost levels where much agricultural disturbance has taken place. Subsequently very little faunal material was recovered. Of the seven fragments screened, two are only identifiable as large mammalian (cow or bison) vertebral fragments. One is a burned centrum fragment and the other is an unburned, unfused epiphyseal fragment indicating at least two individuals of two different ages.

Less than one-third of the faunal remains from each component is burned and most of these are lightly charred. The burned identifiable elements consist of vertebrae and toes. One of the fragments from the backhoe trenches is burned.

The bones from the trenches consist exclusively of deer and bison elements. Several of the deer elements have gnawing marks and one metatarsal fragment is charred along a longitudinal break perhaps in an attempt to facilitate marrow extraction. The deer limb elements all

exhibit spiral fractures near the articular ends. Both adult and sub-adult deer are represented, however, depth and cultural association are not known. All but one element came from trench 3 which is near Area B and may represent portions of the adult and sub-adult individuals in the Round Rock component.

The bison elements originated in three different trenches, but most came from trench 10, located in the southeastern corner of the site. Again depth and cultural association are unknown. A fully fused distal radio-ulna fragment from trench 9 indicates an old individual. Two carpals and a mandible fragment with two intact molars were recovered from the adjacent trench 10. The attrition of the molars also indicates an old individual, so these elements are probably parts of the same bison as the ulna. The length and breadth of the molars are as follow:

M_1 -- L 25.6 mm   B 17.1 mm

M_2 -- L 32.3 mm   B 16.7 mm

Two proximal rib fragments were recovered in trench 2 some 50 meters northwest of trenches 9 and 10. They are unburned but are possibly associated with a hearth found in trench 2. Trenches 9 and 10 also contained evidence of hearths, and the bison elements from those trenches, although unburned, may be in association with those hearths.

Butchering scars, other than spiral fractures, are noted on three deer elements; but scavenger gnawing and poor preservation inhibit accurate determination on other fragments. Cut marks appear on a proximal radius from San Marcos component, a left calcaneum and left distal humerus from the Round Rock component. All are shallow, V-shaped grooves located on tuberosities where strong tendons and muscles attach. No bone tools were recovered.

Summary

The identified faunal remains from 41WM163 are limited to large mammal elements except for three unburned fragments from possibly intrusive animals--gopher, snake and turtle. Coarse screening effectively eliminates chances of recovering evidence of small riparian species which were probably available to site occupants.

Although two features were detailed in the field notes as containing bone, no field bags indicated feature bone. Therefore, all bone was recorded as level bone. Considering the exclusivity of the identified taxa, these features undoubtedly contained deer or bison.

The following chart gives the numbers of elements per species for each component in Area B and the backhoe trenches:

	Toyah Lv. 1-3	Twin Sisters Lv. 3-8	San Marcos Lv. 9-10	Round Rock Lv. 11-16	BHT
Pocket Gopher				1	
Deer		4	6	15	9
Bison			1		6
Large mammal	2			1	
Colubrid				1	
Turtle sp.					

Area A yielded 104 fragments from one 1 x 1 meter square, however, none were identifiable. Area B (consisting of two 1 x 1 meter squares) yielded 267 bones of which 31 are identifiable. One hundred and eight fragments came from 6 of 11 trenches, and 15 of these are identifiable. Appendix C gives totals for burned and unburned bones per level for excavation.

Site 41WM230

The Loeve-Fox Site covers more than two hectares of an alluvial terrace west of a large bend in the San Gabriel river between the present farms of Mr. C. Loeve and Mr. H. Fox. The Taylor prairie lies 45 meters northwest of the site which, like the others in Granger Reservoir, is situated in the Texan biotic province (Blair 1950). The past occupants of this site hunted in an ecotone with woodlands on the floodplains and grasslands nearby on the prairie. The faunal remains collected from the 1978 excavations indicate subsistence exploitation of both woodland and prairie forms as well as utilization of aquatic forms from the river. Lists of identified taxa are given in Tables 15.7-30, 31 for contents by excavation unit (XU's) and in Tables 15.7-A - 15.7-F for contents by cultural component.

Approximately 25,000 fragments of bone were recovered from seven of the nine units excavated by archaeological teams under the direction of Elton Prewitt during the 1978 season. Material from Prewitt's previous seasons there (Prewitt 1974) is not included in the present analysis. For this report, each excavation unit is discussed separately and then the chronological sequence of occupations is summarized for the site as a whole. Features are described following the site discussion.

XU-1

This unit primarily consists of human burials, cremated and non-cremated. Of the 9,600 fragments recovered only 3.5% are animal remains

TABLE 15.7-30. Faunal Summary for 41WM230

COMPONENT	AUSTIN/ TOYAH	AUSTIN	TOYAH	TWIN SISTERS	SAN MARCOS	ROUND ROCK
AREAS	A Lv 1-5 C Lv 2-4	A Lv 6 E Lv 5-11	H Lv 1-11	A Lv 7-10 C Lv 5-20	C Lv 21-33	C Lv 34-39 I Lv 6-12
Vol. m^3	9.4	3.5	2.4	25.0	4.75	2.23
TOTAL BONE	4314	4368	255+	11180	1433	601
DENSITY/m^3	512	1248	-	447	301	267
# ID	719	164	27+	1744	74	36
% ID	15.0	3.8	10.6	15.6	5.0	5.9
MAMMALS	*79.1%*	*72.6%*	*100.0%*	*71.8%*	*87.8%*	*91.7%*
BIRDS	*1.5%*	*1.8%*	-	*1.5%*	-	-
REPTILES	*16.8%*	*18.9%*	-	*21.0%*	*8.1%*	*8.3%*
AMPHIBIANS	*1.1%*	*3.7%*	-	*1.4%*	*1.4%*	-
FISH	*1.4%*	*3.1%*	-	*4.5%*	*2.7%*	-
TOTAL % BURNED	42.0	71.5	1.0	33.8	33.9	17.9
ID % BURNED	2.0	5.0	0.0	5.0	13.5	19.4

+ Almost complete bison skeleton.

identified to some taxonomic level. Fragmentation is severe and preservation is poor causing added difficulty in distinguishing human from non-human bone. The sorting methodology dictated exclusion of obvious human bone, that is, elements with diagnostic human morphology were not counted during faunal analysis sorting procedures. Unavoidably, some human bone has been included in the total fragment count.

The identified faunal material (Table 15.7-30) was removed from 15 levels spanning Round Rock, Twin Sisters, Austin and Austin-Toyah occupation zones. The Round Rock component contains 18 identified taxa or categories of fauna including opossum and shrew which are absent from the two succeeding occupations. Furthermore, this component yielded the most deer elements (17) all from XU-1 (Table 15.7-31).

The minimum number of deer is estimated at two individuals based on the presence of well-worn adult molars as well as one deciduous molar. There are no recognizable long bone fragments. The identified elements consist of teeth, petrous processes and lower leg and feet bones which tend to indicate on-site butchering activity.

Medium mammals are represented by canid remains consisting of a well-worn maxillary first molar and pelvis fragment. Although abraded, the molar compares well with coyote. Neither fragment is burned.

Fine screening revealed a high frequency of rodent remains. Three individual voles were recorded out of 28 mircotine elements from Round Rock levels at XU-1. The other components there had only one or two elements each, usually teeth. Exact species of vole has not yet been determined, but the woodland inhabiting pine vole (Microtus pinetorum) is a likely candidate and is still found in the region today. Likewise, pocket mouse remains are either Perognathus merriami or P. hispidus, both of which currently occur in Williamson Co.. Neither rodent genus burrows deeply, and the question of their possible intrusiveness is indeterminable since they may have died naturally at the site during or shortly after human occupation. Cotton rats are larger and may have been a food source since there is one element from this component that is burned. The pocket mice and cotton rat are grassland dwellers. Unspecific rodent remains (unidentifiable to species) rank third in frequency and fish elements rank fourth.

All of the fish elements are very small and compare well with gizzard shad (Dorosoma cepedianum). More fish elements were recovered from the Round Rock levels than from any other component.

Additional aquatics found only at these lower levels include bullfrog and small catfish. Turtle is present but in very small densities, and yet most of the fragments are burned.

The Twin Sisters occupation zone at XU-1 contained less than half of the volume of the preceding zone, and therefore, shows higher densities

Table 15.7-31. Total Number of Elements by Vertical Provenience, Site 41WM230.

XU-1

	AUSTIN/TOYAH					AUSTIN					TWIN SISTERS					ROUND ROCK				
SPECIES Lv.	1 - 5	(T)	(B)	MNI	$2.5m^3$	6	(T)	(B)	MNI	$.5m^3$	7-10	(T)	(B)	MNI	$2.0m^3$	11-15	(T)	(B)	MNI	$5.9m^3$
Opossum	1	-	-	1	.40											1	(1)	-	1	.20
Least Shrew	1	-	-	1	.40											2	-	-	1	.30
Rabbit	1	(1)	-	1	.40	2	-	-	1	4.00	2	-	(1)	1	1.00	1	(1)	-	1	.20
Pocket Gopher	4	-	-	1	1.60	12	(6)	(2)	2	24.00	16	(8)	(1)	2	8.50	1	(1)	-	1	.20
Pocket Mouse	1	-	-	1	.40	2	(1)	-	1	4.00	5	(3)	-	1	2.50	5	(2)		1	.90
Fox Squirrel	1	(1)	-		.40	1	(1)	-	1	2.00	1	(1)	-	1	.50					
Pygmy Mouse						1	-	-	1	2.00	1	-	-	1	.50	1	-	-	1	.20
Grasshopper Mouse	3			2	1.20															
Deer Mouse						1	-	-	1	2.00	2	-	-	1	1.00					
Cotton Rat	11	(4)	-	3	4.40	5	(2)	(1)	1	10.00	5	(2)	(1)	2	2.50	9	(5)	(2)	2	1.50
Vole	1	1	-	1	.40	2	-	(1)	1	4.00	3	(1)	(1)	1	1.50	28	(11)	-	3	4.80
Beaver						1		(1)	1	2.00										.30
Dog sp.						1				2.00						2	(1)	-	1	2.90
Deer	11	(1)	(3)	2	4.40	4	(1)	(1)	1	4.00	13	(3)	(4)	2	6.50	17	(7)	(2)	2	2.50
Rodent	17	(9)	-		6.80	34	(12)	(1)		68.00	32	(16)	(1)		16.00	15	(4)	-		
Medium mam.	1	-	-		.40	2	(1)	(1)		4.00	1	(1)	(1)		.50					
Large mam.	1	-	-		.40	2	-	(1)		4.00	2	(2)	-		1.00	2	-	-		.30
Bird sp. small						3	-	-		6.00	2	-	-		1.00					
Bird sp. medium											1	-	(1)		.50					
Turtle sp.						3	-	(1)		6.00	5	-	-		2.50	3	-	(2)		.50
Box Turtle											1	-	-		.50					
Snake sp.	2	-	-		.80	6	-	-		12.00	9	-	-		4.50					
Viper	1	-	-		.40											4	-	-		.70
Colubrid	1	-	-		.40	4	-	-		8.00	5	-	-		2.50	3	-	-		.50
Lizard sp.	1	-	-		.40															
Frog sp.						3	-	-		6.00										
Bullfrog																1	-	-		.20
Fish sp.						1	-	-		2.00	3	-	-		1.50	12	-	-		2.00
Catfish																1	-	-		.20
TOTAL ID	59					90					109					108				

(T) = No. of teeth included in total.
(B) = No. of burned elements included in total.
m^3 = Volume excavated and element density per taxon.

for elements per species. Noticeably reduced are frequencies of voles and fish. Rodent remains rank first in prevalence, and pocket gopher is the most frequently identified rodent from this component.

Two individual deer are indicated by adult and deciduous teeth. The young age of the fawn suggests a late summer death. One third of the deer remains are charred.

Fish remains are reduced in abundance when compared with the Round Rock sample. Other aquatics are not well represented either.

The unmixed Austin component was located in level 6 with a volume of .5 m^3. Element counts and densities are rather high suggesting an intensive occupation. However, very few large mammal remains were recovered. For example, only two deer elements were identified and two others are deer size.

The majority of identified remains, therefore, are from small animals. Rodent bone density is greatest in this component with pocket gopher in prevalence. Although this deeply burrowing rodent is often considered intrusive, some gopher elements are burned in addition to those of other rodents.

The aquatic environment is also represented in this component. Frog and fish remains are present as well as beaver which is the only occurrence of this aquatic mammal at XU-1.

The uppermost component contains artifacts of both Austin and Toyah cultures. The faunal material differs from the preceding component. In the absence of birds, turtles, and fish. Rodents predominate with cotton rat as the most common small mammal. Deer remains are equal in density to cotton rat, and with one exception, a broken left ulna, consist of cranial and feet elements. There is no visible indication of modification of the ulna.

There is a reappearance of shrew and opossum in this component that had not been represented in the two middle occupations. Least shrews prefer grasslands and are often found in conjunction with cotton rats. Opossums prefer woodlands but may also be found in prairies and marshes (Davis 1974). From these small samples, it is unwise to suggest an environmental explanation for the absence of these two mammals in the occupation components between Round Rock and Austin/Toyah.

Only one fragment from each occupation component shows evidence of cut marks. All are deer size and each is different in execution. A fragment from level 14 exhibits a cut and snap break. Another from level 7 has four deep, v-shaped notches. One from level 2 has four light, parallel scratches running longitudinally. The body elements from which each of these fragments originates is indeterminable. No discernment of cultural pattern is possible.

XU-2

No cultural affiliation has been designated for this unit, and only two levels were excavated. Less than 200 bone fragments were recovered of which 36% were identifiable. These come only from level 2 and include opossum, least shrew, rabbit, fox squirrel, pocket gopher, pocket mouse, and beaver (one individual each). Four individual cotton rats were identified from 16 elements. No burned elements were recorded for any of these mammals.

One deer is represented by only three elements, one of which is burned. These elements consist of feet bones. Likewise, seven bison (?) elements recovered are all fragments from phalanges and carpals/tarsals. No bison bones are burned.

Reptiles are the only non-mammals identified. A rat snake vertebra and a plastron fragment from a musk or mud turtle comprise this group. Neither is burned.

XU-3

Approximately 13,000 pieces of bone are recorded from this large excavation area. Nineteen percent are identifiable to some degree and encompass almost 50 different taxa from all vertebrate classes. These remains are concentrated in the upper 20 levels at XU-3 which contain Late Archaic (Twin Sisters) and Post Archaic (Austin/Toyah) artifacts. The lower levels are divided into Round Rock and San Marcos components and contain much less faunal debris.

Identified faunal remains from the Round Rock component (Table 15.7-32) are negligible. Preservation is fairly good although less than 400 bone fragments were recovered from a volume of almost 2 m^3. Only 16 elements were identifiable and half of these are deer. Elements of deer consist of 7 teeth and 1 burned phalanx fragment. The teeth are all maxillary from a mature individual. The only other burned element is a sacrum fragment identified as beaver.

The total bone removed from almost 5 m^3 volume of the San Marcos component amounts to 1,433 fragments, but only 5 percent of these are identifiable. Preservation is very poor resulting in badly pitted bone surfaces and severe splintering of the larger elements. The category with the largest element count is the large mammal division based solely on size and consisting completely of broken tooth enamel fragments. These fragments are too thick for deer and may be bison since a bison premolar was recovered from level 27. This mandibular premolar has little wear, and the existing root is still slightly open suggesting a young adult bison.

The non-mammalian remains for the San Marcos occupation at XU-3 suggest some use of the aquatic environment. Fish, frog, and soft-shell turtle are represented among others.

Table 15.7-32. Total Number of Elements by Vertical Provenience, Site 41WM230.

XU-3

SPECIES	AUSTIN/TOYAH					TWIN SISTERS					SAN MARCOS					ROUND ROCK				
Lv.	2 - 4	(T)	(B)	MNI	6.9m³	5 -20	(T)	(B)	MNI	23m³	21-33	(T)	(B)	MNI	4.75m³	34-39	(T)	(B)	MNI	1.85m³
Opossum	32	(2)	-	2	4.63	64	(5)	-	2	2.78	-					1	(1)	-	1	.54
Least Shrew	7	-	-	4	1.01	8	-	-	3	.34	-					-				
Short-tailed Shrew	3	-	-	3	.43						-					-				
Bat sp.	-					1	-	-	1	.04	-					-				
Cottontail Rabbit	12	(1)	-	1	1.73	36	(5)	(1)	4	1.56	1	(1)	-	1	.21	-				
Jackrabbit	1	-	-	1	.14	6	(1)	(2)	1	.26	-					-				
Fox Squirrel	9	(2)	-	2	1.30	12	(8)	(1)	2	.52	-					-				
Pocket Gopher	26	(11)	(2)	3	3.76	134	(60)	-	15	5.82	4	(2)	(1)	1	.84	-				
Pocket Mouse	5	(1)	-	1	.72	26	(6)	-	3	1.13	-					-				
Beaver	-					6	(5)	-	1	.26	-					1	-	(1)	1	.54
Harvest Mouse	1	(1)	-	1	.14	3	(1)	-	1	.13	-					-				
Deer Mouse	4	-	-	2	.57	16	-	(1)	4	.69	1	-	-	1	.21	-				
cf. *Pygmy Mouse*	2	-	-	1	.28	4	(1)	-	1	.17	-					-				
N. Grasshopper Mouse	-					4	-	-	1	.17										
Cotton Rat	143	(59)	-	21	20.72	126	(82)	-	8	5.47	3	(3)	-		.63	-				
Woodrat	6	(1)	-	1	.86	3	-	-	1	.13	1	-	-	1	.21	-				
Vole	13	(7)	-	3	1.88	42	(23)	-	6	1.82	1	(1)	-		.21	-				
Dog sp.	-					12	(3)	(3)	1	.52	-					-				
Raccoon	-					1	(1)	-	1	.04	-					-				
Pig(Lv. 1 only)	5	(2)	-	1	.72	-					-					-				
Deer sp.	39	(15)	(5)	2	5.65	201	(108)	(29)	4	8.73	12	(7)	(2)	1	2.52	8	(7)	(1)	1	4.32
cf. Pronghorn	1	-	-	1	.14	2	-	(1)	1	.08	-					-				
Cow/Bison	17	(14)	-	2	2.46	4	-	-	1	.17	1	(1)	-	1	.21	-				
cf. Human	-					1	-	-	1	.04	-					-				
Rodent	162	(37)	(2)		23.47	392	(120)	(3)		17.60	9	(2)	-		1.89	1	(1)	-		.54
Small mam.	21	-	(3)		3.04	40	(3)	(1)		1.73	-					-				
Medium mam.	9	-	(2)		1.30	7	(1)	(1)		.30	-					-				
Large mam.	2	(1)	(1)		.20	19	(5)	(5)		.82	32	(32)	(5)		6.73	2	(2)	-		1.08

Table 15.7-32. Total Number of Elements by Vertical Provenience, Site 41WM230, continued.

XU-3, continued

SPECIES	AUSTIN/TOYAH					TWIN SISTERS					SAN MARCOS					ROUND ROCK				
Lv.	2 - 4	(T)	(B)	MNI	$6.9m^3$	5 -20	(T)	(B)	MNI	$23m^3$	21-33	(T)	(B)	MNI	$4.75m^3$	34-39	(T)	(B)	MNI	$1.85m^3$
Bird sp. small						2	-	-		.08	-					-				
Bird sp. medium	2				.28	4	-	-		.17	-					-				
Turkey	1	-	-		.14	1	-	(1)		.04	-					-				
Owl sp.	1	-	-		.14						-					-				
Prairie Chicken						5	-	-		.21	-					-				
Bobwhite	2	-	-		.28	1	-	-		.04	-					-				
cf. Crow	1	-	-		.14						-					-				
cf. Thrasher	1	-	-		.14	1	-	-		.04	-					-				
cf. Warbler sp.						3	-	-		.13										
cf. Cardinal	1	-	-		.14	1	-	-		.04										
Perching Bird sp.	2	-	-		.28	6	-	-		.26										
Turtle sp.	3	-	(1)		.43	49	-	(19)		2.13	2	-	(1)		.42	-				
Pond Slider						7	-	(7)		.30										
Box Turtle						1	-	-		.04										
Musk/Mud Turtle	1	-	-		.14	3	-	-		.13										
Softshell Turtle						2	-	-		.08	1	-	(1)		.21					
Snake sp.	21	-	-		3.04	74	-	(1)		3.21	-					2	-	-		1.08
Viper	9	-	-		1.30	63	-	(4)		2.73	-					-				
Colubrid	61	-	-		8.84	127	-	(3)		5.52	3	-	-		.63	1	-	-		.54
Hog-nosed Snake	-					3	-	-		.13	-					1				
Rat Snake	7	-	-		1.01	1	-	-		.04	-					-				
Lizard sp.	14	-	-		2.02	14	-	-		.60	-					-				
Frog sp.	7	-	-		1.01	21				1.00	1	-	-		.21	-				
Bullfrog						2				.08	-					-				
Salamander	1	-	-		.14															
Fish sp.	10	-	-		1.44	71	-	-		3.08	2	-	-		.42	-				
Catfish						2	-	-		.08										
Gar						1	-	-		.04										
TOTAL ID	665					1635					74					17				

(T)= No. of teeth included in total. (B)= No. of burned elements included in total. m^3= Volume excavated and element density per taxon.

The Twin Sisters component spans 15 levels with a volume of 23 m^3. A total of 8,413 bone fragments were recovered resulting in an overall density of 366 bones per cubic meter excavated. Based on number of bones per level, the most intensive use of the areas by this culture group occur in levels 5-10. Level 11 has several features that contain bone, but the number of bones per level drops dramatically from over 1,000 peices in level 10 to just under 400 peices in level 11, and then the counts maintain less than 100 pieces through level 20. Feature 70 is the only exception below level 13. (See Appendix C).

Ninety percent of the identifed faunal remains occur in levels 5-10. This fact changes the significance of the density figures given in Table 8.5-31 in which the density of elements per taxa are computed using the total volume of the Twin Sisters component. Instead of 23 m^3, the adjusted volume for these intensively occupied levels (5-10) would be 7.6 m^3.

The density of deer, therefore, would be almost 27 elements per cubic meter instead of 8.7. Approximately 17 cotton rat or pocket gopher elements would appear in every cubic meter, and the density of other, unspecified, rodent bones would occur at the rate of 53 per cubic meter. Some of the more important non-mammal food remains would also change. For example, adjusted fish bone density is 9.3 per cubic meter and turtle, 6.5.

Species diversity for this component is notably high. With only four exceptions (short-tailed shrew, salamander, and several bird species), the full complement of animal taxa found at Loeve Fox is represented in the upper portion of this component. Economically important large mammals are represented by bison, pronghorn, and deer. The first two are minimally represented, but their presence indicates their use and availability.

Deer is of paramount importance, and of all components at Loeve Fox, the greatest abundance is found here. At least four individual deer are indicated by premolars of different ages at death. One fawn aged between 3 and 5 months old is represented indicating an early winter death. Two individuals were just under two years old at death, and one was at least 5 years old when it died.

Butchering marks are visible on only three elements, a burned proximal fragment of a first phalanx, an astragalus, and a burned occipital condyle. All cuts were made in the initial dismembering process to free the carcass of head and feet. Furthermore, head and feet elements are the only elements that are burned suggesting that as refuse they were discarded into an open fire perhaps to avoid scavenger confrontations.

Unlike other deer assemblages, this one contains a few recognizable long bones, the meatier elements, which tend to substantiate on-site food consumption. Portions representing all of the previously mentioned age groups are found although the delicate bones of the fawns are underrepresented. The scarcity of elements is explained by the extensive

rodent and larger carnivore gnawing apparent on most of the identified elements. This problem further impedes detection of butching marks.

Medium mammals are represented by raccoon, opossum, beaver, and dog. Only one individual raccoon and beaver are represented, soley on dental evidence. The dog remains are more puzzling. The dog teeth are all from an adult as well as the other elements (phalanges, rib, femur head, vertebrae and scapula). The scapula and rib are unusually well preserved, almost complete, unburned, and barely gnawed. The femur head and vertebrae are heavily charred and fragmentary. It is tempting to assume that these remains are from more than one dog. Furthermore, canid remains were recovered from 40 cm (levels 6-10) and several different squares separated by as much as 6 meters, seemingly deposited without pattern. With these few, disparate elements, (MNI) the minimum number of individuals cannot positively be assessed, nor can exact species be determined.

At least two opossum are represented in the assemblage primarily by vertebrae, teeth, and various long bones. These remains show no evidence of burning and it is likely that they are intrusive since opossums are known to occupy other animals burrows. Although their association with human artifacts and activities in level 10 is suggestive of utilization, most of these elements occur clustered in that level as if undisturbed after death.

Rabbits and squirrels, on the other hand, must have supplied quick and easy sources of protein. Element counts and MNI are low, suggesting that these animals may have been used incidentally or only when larger game was scarce.

Rodent remains are abundant. However their utility as food sources is questionable. Only one element from the diminutive deer mouse genus is recorded as burned, and that may have been fortuitous. Many individual cotton rats and pocket gophers are noted (Table 15.7-32), but no elements are burned and no butchering marks are apparent.

Of the non-mammals, birds are the most interesting because of the variety represented here. Even though some of the identifications are inexact because of breakage, this component contained more diverse bird-life than any other from either reservoir. Fine screeing techniques ensured the retrieval of bones of small birds that perhaps have no association with the human occupation. However, Parmalee (1977) cited many instances of historic Indian use of small perching birds in rituals as well as subsistence. Knowledge of snares and other traps are inferred by the presence of ground-dwelling birds such as prairie chicken and bobwhite. A single turkey bone is the only burned bird element. Unfortunately these birds are not good seasonal indicators for Central Texas as most of them are non-migratory or too imprecisely identified to be used as indicators.

The reptilian assemblages is almost as diverse as the avian group. At least four different turtles and two snake genera are recorded from among the nearly 350 elements recovered. Usually it is not too difficult to distinguish poisonous (viperid) from non-poisonous (colubrid) snake vertebrae, but fragmented vertebrae are much more difficult to identify to genus or even family. Hog-nosed snake has more easily distinguishable vertebrae than other non-poisonous snakes and so do members of the genus Elape or rat snakes. Neither type is difficult to catch by hand. In fact, the hog-nosed snake will stop and "play possum" when confronted. Both are native to Williamson County and were probably collected and eaten by aboriginal inhabitants. Several of the unspecific snake elements are burned which occurs easily when the vertebrae and ribs are exposed during roasting.

Besides snakes and turtles, lizard remains are abundant in this component. They were probably used as food when found during foraging. In an early ethnozoology of a late nineteenth century West Texas group, Henderson and Harrington (1914) assert that their informants believe that their ancestors were "addicted to the use of reptiles for food."

Aquatic turtles are the forms most commonly identified in this assemblage indicating the importance of exploiting the riverine environment at Loeve-Fox. Furthermore, the abundance of frog and small fish remains support the notion that after mammalian food, aquatic resources were important during the Twin Sisters occupation.

The uppermost levels at XU-3 is another component of mixed Austin/Toyah artifacts. Preservation is relatively good allowing higher than average percent identifiable remains (26%). A total of 2,536 bone fragments are recorded with the bulk of the osteological material originating from level 2. Quite likely, level 1 is part of the post-contact disturbance associated with the plow zone because a few pig bones were recorded in that level. Rodent remains also increase in abundance in these upper levels where they can be more easily considered intrusive although two pocket gopher elements and two unspecified rodent elements are burned.

Another possibly intrusive opossum occurs in this zone as a cluster of elements in level 2. There is no evidence of butchering or burning to suggest its utilization as a food source. Similarly, shrew elements are questionable food items. Two shrew species are identified: least shrew (Crpototis parva) is common in the area today, but the larger short-tailed shrew (Blarina brevicauda) is currently found farther east.

Of the potentially utilized faunas, there is little evidence of preference change in the types of animals found in this later period of occupation. Deer is still the dominant meat source although fewer individuals are recorded for this component. The increase bison remains may account for the decrease in deer elements. The recovered bovine elements are primarily loose teeth from two rather young individuals, as determined by minimal wear on the occlusal surfaces of the molars. The more complete

teeth in this assemblage are much larger than modern cattle molars of comparable age, therefore, confirming the species as Bison bison instead of Bos taurus. The three non-dental elements are fragments of terminal phalanges without traces of butchering marks.

There is a reduction in the number of elements of birds and aquatic non-mammals although most of the taxa found in the Twin Sister component are also found in this Austin/Toyah amalgam.

XU-4

No bone is recorded from this excavation unit.

XU-5

This unit is divided into two occupation zones, levels 1-4 are designated as a possible Toyah component, and levels 5-11 are associated with Austin type artifacts.

Approximately 950 osteological fragments are recorded for the entire unit with 78% coming from the Austin component. Only 10% of the Austin component bones is identifiable. The bulk of the material is composed of very small deer-sized fragments in a poor state of preservation. Both zones are dominated by remains of small animals, primarily rodents and reptiles. Deer bones are present in both zones, but the deer samples consist mainly of fragmented dentition. The few non-dental elements are unburned (with one exception in level 7) and unmodified. Of five features located in this excavation unit, none has identified deer remains.

XU-6

No bone is recorded from this excavation unit.

XU-7

A total of eleven bone fragments is recorded, and four of these are identified. The identified material consists of a rabbit maxilla, a cotton rat tibia, a pocket gopher mandible fragment, and a snake vertebra fragment. All are unburned and unmodified.

XU-8

This Toyah component is unlike any of the others at Loeve-Fox in that the faunal assemblage is very poor in species diversity and rather complete in the quantity of skeletal material present for two of the species. Simply

stated, there is evidence for a nearly complete bison carcass and many skeletal elements of dog from among the 249 bone fragments. The bison skeleton is counted as one entity and is fully discussed in the feature descriptions that follow (Feature 66).

The dog remains consist of seven phalanges, one distal metapodial fragment, a carpal, as well as a right eye orbit and right mandible with teeth intact. The excavators used at least three different substances to stabilize this very friable mandible: a thin film of a soluable nylon preparation covers the entire surface, duco-cement was used to affix a fragment of the ascending ramus, and some unknown plaster-type paste was used to secure the extremely worn canine but has oozed and filled the premolar socket posterior to it. Exact species cannot be determined. No butchering marks are visible. It is unburned. It is too incomplete to assume intentional burial, and furthermore, may be the result of scavenged natural demise.

Deer remains are all but completely absent from this assemblage. One deciduous molar is recorded. The paucity of deer remains and the presence of a seemingly unbutchered bison confuse the assessment of the site's activity basis. If it is a bison kill site, then why was the bison left unbutchered? If it is a camp site, why are there so few deer remains? Despite the presence of lithic artifacts, the faunal material suggests that limited subsistence activity occurred there if at all. Judgment of site activity should be reserved because too small an area was excavated.

XU-9

The faunal remains from this Round Rock unit consists of 277 fragments in very poor condition. Only 7% are identifiable, and they are primarily dental fragments. Of the twenty-two identified elements, all but one rabbit humerus fragment were recovered from fine screening one quarter of the material. These small elements represent remains of cotton rat, pocket gopher, unspecific rodent, and deer (one tooth fragment), all unburned. The unidentifiable sample contains some burned fragments of deer sized bones, but mostly consists of tiny chips of undeterminable origin. The associated features suggest that this unit may be the periphery of a refuse pile. Overall density for osteological debris is 62 fragments per cubic meter.

Features

As of this writing, 137 features have been designated in the area of the Loeve-Fox Site. Fifty-nine of these yielded bone which total approximately 4,800 fragments. Eight percent of this total are identified to some taxonomic degree. Table 15.7-33 summarizes the faunal remains from these features. This information is presented in numerical order for easier cross-reference with other sections of the larger report. The osteological

Table 15.7-33. Summary of Faunal Material from Loeve-Fox Features.

Feature	Unit	Culture	Type	Total[a] #B	Total[a] #UB	Identified[b] #B	Identified[b] #UB	Contents:[c]
20	5	Austin	burned clay pit	0	14	0	3	rodent (2), lizard (1).
30	3	Twin Sisters	basin hearth	3	55	0	13	rodent (4), pocket gopher (4), pocket mouse (2) sm. mam. (1), snake (2).
31	3	Twin Sisters	basin hearth	6	15	0	4	rodent (2), sm. mam. (1), deer (1 phalanx).
34	3			39	12	0	2	
36	1	Austin	burial pit					human (only).
37	3	Austin	burned clay lens	42	31	2	1	deer (1 distal tibia, 1 cuneiform), crow (1).
38	3	Austin	burned clay pit	2	65	0	19	sm. mam. (4), cotton rat (3), opossum (2), pocket gopher (2), rodent (2), deer mouse (1), fox squirrel (1), fish (4).
39	3	Twin Sisters	burned tree	20	140	2	32	rodent (10), vole (3), shrew (2), cotton rat (2), rabbit (1), fox squirrel (1), deer mouse (1), deer (1 tooth), bison (1 epiphyseal), bird (3), snake (3), lizard (2), frog (1), fish (3).
39A	3	Twin Sisters	burned tree	0	42	0	10	rodent (2), pocket gopher (1), vole (1), deer mouse (1), prairie chicken (1), snake (4).
40	3	Historic	burned tree	6	107	1	36	opossum (8), rodent (6), pocket gopher (5), cotton rat (3), sm. mam. (2), med. mam. (2), rabbit (1), woodrat (1), pocket mouse (1), snake (7), lizard (1), fish (1).
41	3	Twin Sisters	basin hearth	3	10	0	5	sm. mam. (3), fish (2).
42	3	Austin	burned clay pit	2	21	0	6	rodent (4), bird (1), lizard (1).
43	3	Twin Sisters	burned tree	4	19	0	7	deer (2 cranial), rodent (2), pocket gopher (1), deer mouse (1), bison (1 carpal).
45	3	Austin	burned clay pit	0	10	0	8	rabbit? (2), cotton rat (2), rodent (1), snake (2), fish (1).
46	3	Twin Sisters	basin hearth	0	1	NONE		

Table 15.7-33 . Summary of Faunal Material from Loeve-Fox Features, continued.

Feature	Unit	Culture	Type	Total[a] #B	Total[a] #UB	Identified[b] #B	Identified[b] #UB	Contents:[c]
48	3	Twin Sisters	burned clay pit	0	25	0	10	rodent (5), cotton rat (2), rabbit (1), pocket gopher (1), snake (1).
49	7	Twin Sisters	basin hearth	1	4	0	2	pocket gopher (1), cotton rat (1).
50	3	Twin Sisters	burned clay pit	0	6	0	2	cotton rat (1), snake (1).
51	3	Twin Sisters	arcuate hearth	1	77	0	18	pocket gopher (4), rodent (3), cotton rat (2), vole (2), deer (1 phalanx), snake (2), frog (2), fish (2).
52	1	--	--	15	21	0	4	rodent (2), cotton rat (1), deer (1 mandible fragment).
53	1	--	--	74	15	NONE		
54	1	Austin	burial pit	1684	338	6	54	rodent (26), pocket gopher (9), cotton rat (5), vole (2), deer (2 phalanges), fox squirrel (1), pocket mouse (1), pygmy mouse (1), deer mouse (1), med. mam. (1), bird (2), snake (8), fish (1).
56	1	--	--	623	59	0	4	pocket gopher (2), rodent (1), pocket mouse (1).
57	1	--	--	191	18	1	0	rabbit (1).
58	3	Twin Sisters	burned clay pit	5	18	NONE		
59	5	Austin	burned tree	9	54	1	3	pocket gopher (1), cotton rat (1), rodent (1), snake (1).
60	5	Austin	hearth scatter	1	7	NONE		
61	5	Austin	basin hearth	38	55	0	9	rodent (2), pocket mouse (1), snake (2), frog (2).
63	3	Twin Sisters	arcuate hearth	0	12	0	12	rodent (9), vole (1), snake (2).
64	3	Twin Sisters	arcuate hearth	14	25	0	3	rodent (1), turtle (1), snake (1).

Table 15.7-33. Summary of Faunal Material from Loeve-Fox Features, continued.

Feature	Unit	Culture	Type	Total[a] #B	Total[a] #UB	Identified[b] #B	Identified[b] #UB	Contents:[c]
65	3	Twin Sisters	disrupted	5	68	0	14	cotton rat (4), rodent (3), rabbit (1), pocket mouse (1), snake (5).
66	8	Toyah	articulated skeleton		++		++	bison (1 individual), canid (6), opossum (1) cotton rat (1).
68	3	Twin Sisters	basin hearth	1	14	1	0	snake (1).
70	3	Twin Sisters	burned tree	33	173	0	49	rodent (11), cotton rat (9), vole (3), deer (1 tooth dog (1), sm. mam. (1), bird (1), snake (19), lizard (1), fish (2).
71	3	Twin Sisters	basin hearth	0	14	0	1	rodent (1).
73	3	Twin Sisters	burned clay pit	3	37	0	9	pocket gopher (3), deer (1 tooth), cotton rat (1), snake (2), frog (1), fish (1).
75	3	Twin Sisters	burned clay pit	3	7	0	3	rodent (1), turtle (1), snake (1).
82	3	Twin Sisters	snail cluster	0	7	0	2	cotton rat (1), sm. mam. (1).
83	3	Twin Sisters	basin hearth	0	1	NONE		
86	3	Twin Sisters	basin hearth	2	9	NONE		
87	3	San Marcos	flat hearth	4	4	NONE		
88	5	Austin	burned clay pit	9	21	0	1	sm. mam. (1).
89	1	--	--	18	10	0	4	rodent (2), rabbit (1), snake (1).
90	3	Twin Sisters	snail cluster	3	41	0	1	vole (1).
94	1	--	burned rock scatter	2	6	0	2	rodent (2).
96	BHR-25	Round Rock	basin hearth	4	31	0	1	rodent (1).
99	BHR-2	Twin Sisters	basin hearth	0	15	0	4	rodent (2), cotton rat (1), deer (1 tooth).

Table 15.7-33 . Summary of Faunal Material from Loeve-Fox Features, continued.

Feature	Unit	Culture	Type	Total[a] #B	Total[a] #UB	Identified[b] #B	Identified[b] #UB	Contents:[c]
105	BHR-2	Twin Sisters	basin hearth	0	1	NONE		
107	3	San Marcos	basin hearth	0	57	0	2	rodent (2).
108	BHR-2	Round Rock	disrupted	0	1	NONE		
110	3	San Marcos	mussel cluster	2	6	NONE		
112	9	Round Rock	burned clay lens	0	3	NONE		
113	9	Round Rock	basin hearth	0	3	NONE		
114	9	Round Rock	basin hearth	8	17	0	3	pocket gopher (3).
116	9	Round Rock	basin hearth	0	11	0	3	snake (3).
117	3	Round Rock	burned clay pit	0	14	0	2	deer (1 tooth), rodent (1).
118	3	Round Rock	burned clay lens	4	1	0	1	lg. mam. (1 tooth fragment).
122	3	Twin Sisters	burned clay pit	4	6	0	3	pocket gopher (1), cotton rat (1), rodent (1).

a. Total number of recovered fragments "B"= burned elements; "UB"= unburned elements.

b. Number of identified elements from the total.

c. Taxa and number of elements attributed to each taxa.

++ No element count.

contents of each feature are briefly presented listing the mammalian taxa with the greatest number of elements first and non-mammalian remains last.

With few exceptions, the faunal debris is primarily composed of rodent remains, some of which can be identified to species. Because all of the feature fill was fine-screened, recovery of these small elements was assured. However, the role that these rodents and other small animals (snakes, lizards, frogs and fish) played in subsistence is questionable. Furthermore, the small amount of larger animal bones reinforces the hypotheses that many of the features were either scoured deliberately or naturally after use and consequently yield little interpretable evidence.

The "burned tree" features also suggest that the presence of some of these animals as intrusive. For example, the only burned rodent bone occurs in F-39 along with the only burned rabbit element. Similarly, two other burned tree features (F-70 and F-40) contain burned reptilian remains. It is highly likely that the etiology of all of these elements results from entrapment in a natural conflagratoin.

A puzzling exception occurs with some deer remains from F-43, another burned tree feature. Here, two charred fragments of the basio-occipital portion of a deer skull were recovered. Both have obvious butchering marks running transversely to the long axes. It is conceivable that the discarded skull fragments are coincidental with the tree.

Deer elements are recorded from eleven features: F-31. F-37, F-39, F-43, F-51, F-52, F-54, F-70, F-73, F-99, and F-117. Three of these are burned tree features (F-39, F-43, and F-70). No feature contains more than one or two deer elements and most of these are broken teeth or phalanges. Feature 37, however, contains a left distal tibia fragment and a right cuneiform carpal, neither of which is burned or scarred.

Bison remains appear in three features, F-39 and F-43 (burned trees) and F-66. The burned tree bison remains are small elements (vertebral epiphysis and carpal) which could easily have been transported to the feature area by rodents or flooding. Feature 66 warrants more description as it is an obvious osteological feature.

Feature 66

This feature consists of a nearly complete, articulated bison skelton predominately excavated from level 4 (XU-3). The recovery of five Perdiz points suggests human association. Two of these small, Neo-American projectiles were removed from level 4; one was found in the fill near the flank region of the skeleton, and the other point was located somewhere within a meter of the backbone on the opposite side of the skeleton.

The absence of butchering marks and degree of completeness of the skeleton is problematic with regard to the presence of the projectile

points. Two hypotheses can be made: (1) the association of the skeleton and Perdiz points is coincidental, or (2) the animal was felled for purposes other than meat procurement.

Since the projectile points were not found in direct contact with any skeletal element, the first hypothesis cannot be ignored. Furthermore, the relative completeness of the skeleton suggests that the bison could be "intrusive," and the points "fortuitous."

The second hypothesis assumes human association based on the close proximity of projectile points to the body cavity and requires explanation of certain missing skeletal elements (Fig. 15.7-2).

Most noticeably, the skull is missing. However, many maxillary teeth were recovered as well as the petrous processes from the base of the skull. This suggests that the skull was removed from the site long after decomposition because in order for the teeth to fall free from their sockets and the petrous processes to become separated from the skull, all soft and connective tissues must be absent. Therefore, the bison's skull was not carried off intact immediately after death of the animal. However, based on the position of the atlas, it is possible that the skull was removed from the body at the time of death. McHugh (1972) records evidence of Plains Indians' penchant for the taste of bison brains, whereby the skull is removed and the frontal bone smashed to extract the brain matter. This activity could account for the displacement of the atlas, however, no broken cranial fragments were recovered. Most likely, the skull was left semi-articulated and later (after decomposition) was removed from the site by unknown forces allowing the dispersal of the maxillary teeth and petrous processes.

The missing skull, therefore, does not substantiate direct association with the Perdiz points, but certain other elements are conspicuous by their absence. The backhoe trench revealed the skeleton when portions of the hindquarters were found in the backhoe material. Portions of pelvis and both femurs were recovered in the backhoe material, however no tibiae were found; also underrepresented are cannon bones, tarsals, and tail bones. Possibly these elements were damaged beyond recognition by the backhoe.

Another possibility is that they were detached from the skeleton with the animal's hide (Frison 1974). This conjecture assumes human etiology and supports the second hypothesis. The value of the "buffalo robe" as a trade commodity for the Indians is well documented, as well as its ritual significance, a raw material source, and as an indicator of personal wealth (McHugh 1972; Whitney et al. 1904; Roe 1951; Dary 1974). The skinning techniques cited in these references, however, illustrate methods used primarily by early white butchers in which the skin on the legs is pared off and the hoofs are left articulated. The Indians by contrast, utilized almost everything from bison carcasses butchered for meat and raw materials.

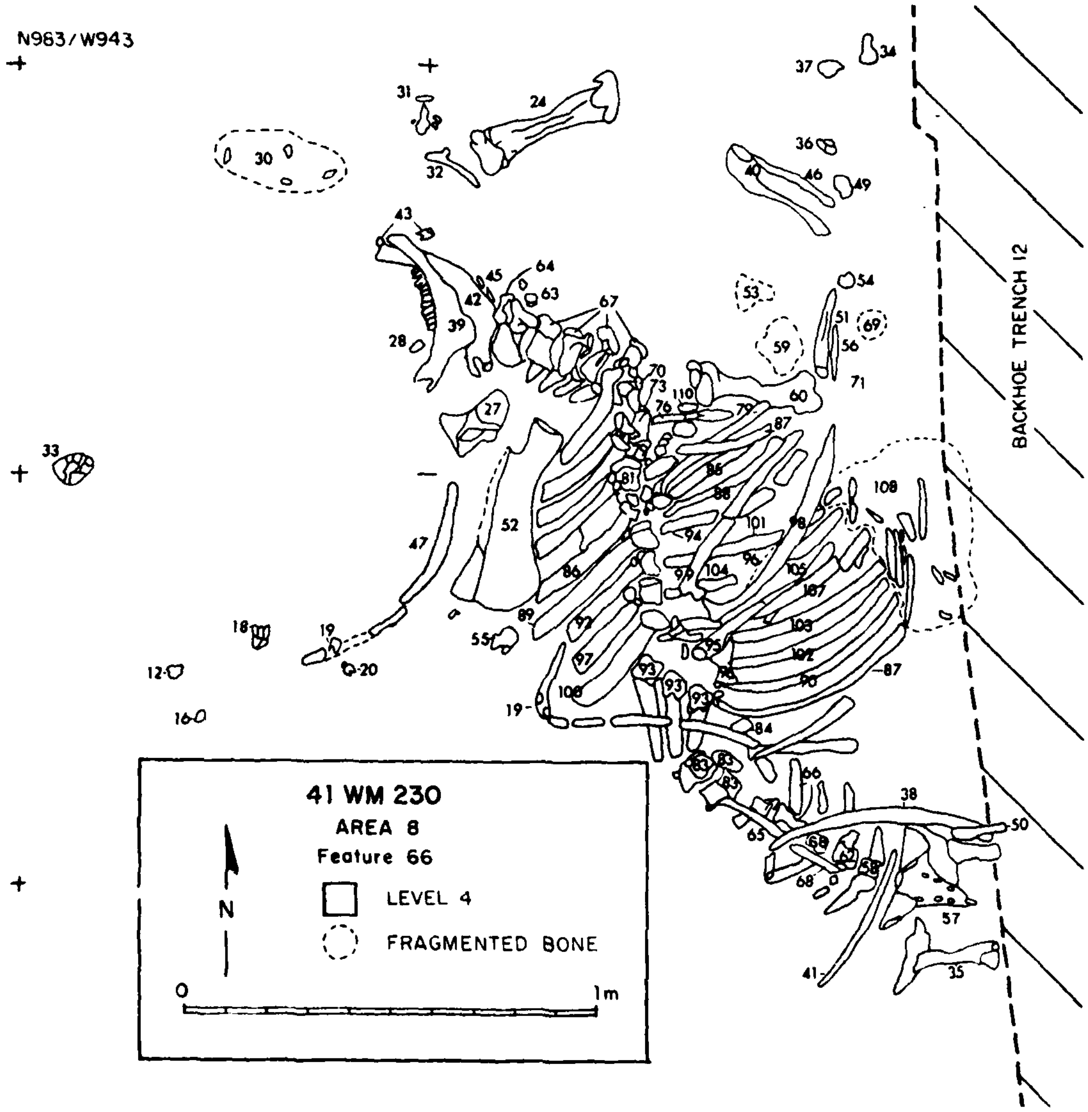


Figure 15.7-2 Bison Skeleton, Feature 66, 41WM230
Key to numbered elements is found on page 8-143
Measurements for selected elements are on Table 8.5-33.

Key to F-66 Bison skeletal elements (omitted numbers not pertinent to map)

1. unit
3. metapodial (Canid)
5. phalange (Canid)
7. maxillary canine (R)(Coyote Canid)
8. metapodial (Canid)
9. unidentified fragments
10. rib
12. mandible (L) (Cottonrat)
13. phalange (Canid)
14. limb fragments
15. metapodial (Canid)
16-19. maxillary premolar
20. maxillary molar
21. petrous ( )
22. unidentified fragments
23. petrous ( )
24. mandible (R) (Opossum)
25. limb fragments
26.
27. atlas
28. maxillary premolar
29. unidentified fragments
30. incisors
31. unidentified fragments
32. hyoid fragments
33. unidentified fragments
34. phalanx I
35. ischium fragments
36. phalanx II
37. phalanx III
38. rib
39. mandible (R)
40. radius (R)
41. rib
42. mandible (L)
43. maxillary premolars (2)
44. ilium (L)
45.
46. ulna (R)
47. rib
48. unid
49. carpal
50. rib
51. radius (L)
52. scapula (L)
53. sternal fragments
54. carpal
55. maxillary molar
56. ulna (L)
57. sacrum
58. lumbar vertebrae
59. sternal fragments
60. humerus (L)
61. rib
62. lumbar vertebrae
63. carpal
64. axis
65. rib
66-68. lumbar vertebrae
69. sternal fragments
70. thoracic vertebra
71. carpal
72-73. thoracic vertebra
74-76. rib
77. thoracic vertebra
78-80. rib
81. thoracic vertebra
82. rib
83-84. thoracic vertebrae (2)
85. rib
86. thoracic vertebra
87-88. rib
89. thoracic vertebra
90. rib
91. sternal fragments
92-93. thoracic vertebra
94-96. rib
97. thoracic vertebra
98-99. rib
100. thoracic vertebra
101-108. rib
109. metapodial condyle
110. scapula ( )
111. astragalus (L)
112. calcaneum (L)

Table 15.7-34. Measurements of Selected Bison Elements from Feature 66 at XU-8 (41WM230)†

Mandible	
Length from angle (basal) incisor sockets broken)	38*
Length from condyle (dorsal)	39.5*
Length of vertical ramus to M_3	11.7
Length of horizontal ramus	24*
Length from angle to P_2	26.5
Length from angle to nuchal border of mental foramen	34
Length of cheektooth row	14.8
Length of molar row	10
Length of premolar row	4.9
Length and breadth of M_3	4.3 x 1.5
Length of diastema	10.65
Height of vertical ramus to condyle	15.3
Mid-height of vertical ramus to notch	16.3
Height of vertical ramus to coronion	21.3
Atlas	
Greatest breadth	19.3
Greatest length	12.4
Breadth of cranial articular surface	13.7
Breadth of caudal articular surface	12
Height	9.5
Axis	
Greatest length of body	12.4
Height	16.6

† Measurements based on A. von den Driesch, A Guide to the Measurements of Animal Bones from Archaeological Sites, Peabody Museum Bulletin 1, 1976.

*Asterisks indicate that a portion of the skeletal element is absent due to breakage and that the measurement is no smaller than the dimension given. All dimensions are in centimeters.

Table 15.7-34. Measurement of Selected Bison Elements
Feature 66 at XU-8 (41WM230) (continued).

Thoracic vertebrae	2nd Thoracic	3rd Thoracic	4th Thoracic
Length of body	43.5*	43.5#	45.0
Greatest height	6.4	6.6	6.6

Lumbar vertebrae	3rd Lumbar	5th Lumbar
Length of body	6.1	6.3
Breadth of anterior articular surface	4.7	5.8
Breadth of posterior articular surface	5.6	7.8

Sacrum	
Greatest breadth (one wing broken)	22.7*
Greatest breadth of anterior articular surface	7.4
Greatest height of anterior articular surface	3.3

Scapula (R)	
Height or total length	40.0*
Length of glenoid process	8.8
Length of glenoid cavity	7.7
Breadth of glenoid cavity	6.0

Humerus (L)	
Greatest length	36.3
Greatest length from caput	32.3
Breadth of distal end	9.1
Breadth of proximal end	14.2
Smallest breadth of diaphysis	5.3

Table 15.7-34. Measurement of Selected Bison Elements
Feature 66 at XU-8 (41WM 230)(continued)

Ulna (L)	
Greatest length (only proximal end recovered)	*
Length of olecranon	12.8
Smallest depth of olecranon	6.6
Breadth across coronoid process	5.6
Radius (L)	
Greatest length	32.0
Smallest breadth of diaphysis	5.2
Breadth of proximal end	9.7
Breadth of distal end	8.0
Pelvis (L) (only ilium fragment intact enough for measurement)	
Smallest height of ilium shaft	4.2
Smallest breadth of ilium shaft	3.2
Femur (R) (2 fragments recovered: proximal end and diaphysis)	
Depth of caput	5.2
Smallest breadth of diaphysis	4.3
Calcaneun (L)	
Greatest length	15.0
Greatest breadth	6.2
Astragalus (L)	
Greatest length laterally	7.6
Greatest length medially	7.2
Greatest depth laterally	4.1
Greatest depth medially	4.3
Breadth of distal end	5.2

Table 15.7-34. Measurement of Selected Bison Elements
Feature 66 at XU-8 (41WM230) (continued).

Phalanges	I Phalanx	II Phalanx	III Phalanx
Greatest length	6.9	4.5	*
Breadth of proximal end	3.8	3.7	2.9
Breadth of distal end	3.7	3.1	*
Smallest breadth of diaphysis	3.6	2.9	-
Middle breadth of sole	-	-	3.0

If the bison at Feature 66 was killed by Indians, it was incompletely butchered suggesting a late occurrence when Plains Indians needed bison hides to trade with whites for items such as coffee and sugar.

Without definite evidence for butchering or skinning, such as cuts on critical elements, the possibility that this bison died of natural causes cannot be discounted.

Summary

The faunal remains from the Loeve-Fox Site represent a diversity of wildlife which is common for an ecotonal environment. Proximity to the river creates the opportunity for hunter/gatherer occupants to exploit riverine woodlands, and yet grasslands are never very far away from the wooded river banks of Central Texas.

Rodent remains are abundant, and the types of rodents identified reinforce the ecotonal character of the site. Nine rodent genera are recorded and each genus is represented in the faunal assemblage by a member species that prefers grassland habitats (except for woodrats which prefer swamps or woodlands). The microtine (voles) species remains unspecific because no diagnostic lower third molars were recovered. There are two voles that have been recorded from Central Texas sites. Witter (1973) identified *M. ochrogaster* from remains at 41WM135 and notes that this vole prefers grasslands. Murry (1978) has identified pine vole (*M.* or *Pitymys pinetorum*), a woodland species, from the Bear Creek shelter. Davis (1974) indicates that this latter species is indigenous to Kerr and Gillespie counties not too far west of Williamson County. Additionally, fox squirrel and woodrat remains suggest availability of woodlands for exploitation as well as grasslands.

Very little exploitative or environmental change is reliably indicated by these samples. For example, aquatic non-mammal remains are common in the Round Rock component of XU-1, but they are totally absent in the same component of XU-3. Likewise, vole bones are abundant in the Twin Sisters component of XU-3 yet negligible in the same component at XU-1.

With an absence of bison, jackrabbit, and pronghorn in the older (San Marcos and Round Rock) components, it is possible to suggest that the grasslands were more remote then than during the later occupations. An increase through time in the relative frequency of grassland rodents tends to reinforce the idea that the prairie environment enlarged after c. 300 A. D. bringing exploitable species such as bison closer into range.

Although deer is the prominent meat source, the contribution of rodents is possible yet difficult to substantiate. Passive hunting techniques and foraging habits could easily provide small game at a minimum of energy expense for the women and children.

Aquatic species also contribute to the occupant's subsistence at all times, but notably during the earliest and latest periods. However, the vagaries of preservation, sampling, and cultural practices prohibit any speculation regarding subsistence activities.

Site 41WM258

The Bigon-Kubala Site, named after the two recent landholders, is located on Willis Creek in the Blackland Prairie section of Williamson County. Excavators were limited to opening three small excavation areas, only one of which revealed more than a 3 x 3 meter area (Area B). The recovered material was screened through ¼" mesh, and no matrix was water screened, thereby limiting the faunal sample to larger bones. Preservation is fairly good although deeper material is slightly more deteriorated due to longer exposure to degenerative forces. Table 15.7-35 shows the amount of faunal material for each component as well as additional collective information on its distribution and density. Table 15.7-36 lists the identified taxa for each component in each area.

The deepest component is believed to be of Late Archaic origins based on projectile points recovered in Area C when compared with later cutlural zones at Area C (Twin Sisters and an unknown cultural affiliation in the upper zone), this Late Archaic component yielded almost as much total osteological debris and a few more identified deer elements than the others.

Twin Sisters components also occur in both Area A and B although only one element was identified (a rodent bone) from the Area B sample. However, deer remains were recovered in some density at Area A and C. These elements consist entirely of teeth and unmeaty lower leg bones. The teeth from both areas are those of a sub-adult individual. No two teeth were duplicates, that is, from the same dental position which would indicate more than one individual. Although separated by 20 meters, it is possible that these sub-adult elements from one excavation area are portions of the same individual found in the others. Alternately, this may reveal a cultural preference for deer of this age group. The remaining species recovered in these Twin Sisters components may be intrusive snake and turtle remains. However, a burned cottontail rabbit mandible from Area C indicates at least supplemental use of this smaller, dependably available mammal.

Austin material was recovered only in Areas A and B. As demonstrated (Table 15.7-36) smaller animals increase in frequency in this component, and though all of the identified elements are unburned, opossum and rabbit are known aboriginal food sources, whereas pocket gopher remains are questionable human food debris because of their burrowing habits and intrusive nature from an archaeological point of view. An unburned canid carpal recovered from Area B represents another animal whose use as food by prehistoric peoples is difficult to demonstrate by singular remains. It appears larger than coyote, but exact species is indeterminable.

TABLE 15.7-35 Faunal Summary for 41WM258

COMPONENT	TOYAH	AUSTIN	TWIN SISTERS	LATE ARCHAIC
AREAS	A Lv 2-5 B Lv 2-6	A Lv 6-7 B Lv 7-10	A Lv 8-10 B Lv 11-15 C Lv 6-8	C Lv 9-15
Vol. m^3	5.1	1.4	1.4	.8
TOTAL BONE	2533	375	319	126
DENSITY/m^3	496	267	227	158
# ID	169	52	35	17
% ID	6.6	13.8	10.9	13.5
MAMMALS	*76.9%*	*94.2%*	*82.4%*	*82.4%*
BIRDS	-	-	-	-
REPTILES	*16.6%*	*5.8%*	*17.6%*	*17.6%*
AMPHIBIANS	*1.8%*	-	-	-
FISHES	*4.7%*	-	-	-
TOTAL % BURNED	14.0	10.0	32.6	21.4
ID % BURNED	11.0	1.9	14.7	23.5

Table 15.7-36. Total Elements by Vertical Provenience, Site 41WM258.

Area A		TOYAH					AUSTIN					TWIN SISTERS			
SPECIES Lv.	2-5	(T)	(B)	MNI	$1.6m^3$	6-7	(T)	(B)	MNI	$.6m^3$	8-9	(T)	(B)	MNI	$.6m^3$
Rabbit						3	-	-	1	5.00					
Fox Squirrel	1	-	-	1	.63										
Pocket Gopher						4	-	-	2						
Cotton Rat	8	-	-	3	5.00										
Woodrat	1	-	-	1	.62										
Medium mam.											1	(1)	-		1.68
Deer	49	(21)	(11)	2	30.63	28	(8)	-	1	46.67	13	(9)	-	1	21.68
Snake	1	-	(1)		.63										
Viper											1	-	-		1.68
Colubrid	1	-	-		.63										
Turtle sp.	14	(2)	(2)		8.75	3	-	-		5.00	2	-	-		3.30
Box Turtle	7	-	-		4.38						3	-	-		5.00
Bullfrog	1				.63										
TOTAL ID	83					38					20				

Area B		TOYAH					AUSTIN					TWIN SISTERS			
SPECIES Lv.	2-6	(T)	(B)	MNI	$3.5m^3$	7-10	(T)	(B)	MNI	$.8m^3$	11-15	(T)	(B)	MNI	$.5m^3$
Opossum	3	-	-	1	.86	1	-	-	1	1.25					
Rabbit	2	-	-	1	.57										
Fox Squirrel	1	-	-	1	.29										
Pocket Gopher	15	(4)	-	2	4.29	1	-	-	1	1.25					
Woodrat	1	-	-	1	.29										
Rodent	2	(1)	(1)		.57	1	-	-			1	(1)	-		2.00
Medium mam.	1	-	(1)		.29										
Large mam.	4	(4)			1.14										
Dog sp.						1	-	-	1	1.25					
Deer	7	(3)	(1)	2	2.00	9	(5)	(1)		11.25					
Cow/Bison	33	-	(1)	2	9.43	1	(1)	-		1.25					
Viper	1	-	-		.29										
Colubrid	2	-	-		.57										
Turtle sp.	2	-	-		.57										
Frog sp.	2	-	-		.57										
Fish sp.	5	-	-		1.43										
Catfish	2	-	-		.57										
Gar	1	-	-		.29										
TOTAL ID	84					14					1				

Area C		UNKNOWN				TWIN SISTERS					LATE ARCHAIC				
SPECIES Lv.	3-5	(T)	(B)	MNI	6-8	(T)	(B)	MNI	$.3m^3$	9-15	(T)	(B)	MNI	$.8m^3$
Rabbit					1	-	(1)	1	3.33	1	-	(1)		1.25
Cotton Rat	1	-	-											
Rodent	1	-	-											
Deer	4	-	-	1	13	(6)	(4)	1	43.33	13	(4)	(2)	1	16.25
Viper										1	-	-		1.25
Turtle sp.	2	-	-							2	-	(1)		2.50
TOTAL ID	8				14					17				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total
m^3= Volume excavated and element density per taxon.

Although deer remains from the Austin components are moderate in density, their presence definitely attests to the animal's importance in the subsistence of this occupation period at the site. Nearly all body parts are recorded including pelvis and scapula fragments which are rarely found at other sites. Butchering marks are rare because the surfaces of most elements are badly eroded. A distal humerus fragment has several transverse, angled cuts (?) just below the missing radial fossa. Other regions on this specimen appear gnawed, hence the questionable origin of these marks. The only burned deer element is a distal metapodial condyle that is burned black. One individual deer is assessed for either area or for the site as a whole.

A single bison tooth is recorded in the Austin component of Area B. However, it is from level 7 in which its actual origin may have been the overlying Toyah component. These two components overlapped in certain units, and the level distinctions are somewhat arbitrary on the faunal tables. Therefore, this bison tooth may not substantiate utilization of bison among these Austin peoples. The tooth is a deciduous first molar whose roots have already dissolved indicating eruption of the premolar which occurs around two years of age. It is further possible that this tooth was shed and deposited naturally at the site and could have fallen in a dry crack later to be unearthed in this component.

The amount of bone from the upper levels clearly distinguishes the Toyah component from the lower occupations. Occurring in both Area A and B, the total density of osteological material is over twice that of other components (i.e., almost 500 fragments per cubic meter). The small and medium mammal remains indicate usage of woodland (woodrat and fox squirrel) and aquatic (fishes and bullfrog) forms, while the presence of bison, cotton rat, pocket gopher, and box turtle indicate that the prairie environment had not been replaced by riparian woods. Rather, these people were more fully utilizing the available resources than the evidence shows for earlier groups.

Deer is still the staple meat source. Two individuals are apparent in the Toyah samples (as determined from two left astragali). Both Area A individuals are young adult deer between 2 and 4 years of age. Several elements of these deer are burned consisting of distal metapodials as well as ulna and scapula fragments. No butchering marks are visible. One fairly well intact metacarpal is charred along the outside of a long break on the anterior length perhaps made during butchering procedures when the defleshed bones are scrapped or charred to remove the tough periosteum prior to cracking for marrow extraction (Gilbert 1973).

The deer sample from Area B is scantier and consists solely of two teeth fragments, a phalanx fragment, a vertebral epipheseal, and two malleoli (tarsals) from different individuals. Therefore, two individual deer are recorded from this sample of only seven elements. The two deer are of different ages as indicated by the size difference in the malleoli and by the presence of deciduous teeth fragments. No butchering marks

are visible although the seventh element, a modified metapodial, is scratched and burned. (See bone tool discussion this volume.)

The small number of deer bones in Area B is offset by the presence of bison there. (Area A yielded no bison material.) Most of the elements are recorded from Feature 2 (discussed later), but eight elements were recovered outside the feature. The sex and age of this individual are not determinable as there are no teeth, horn cores, or epiphyses present except for a vertebral epiphyseal which does not fuse with the centrum until later in life anyway. The other elements consist of two left radii fragments, two left tibiae fragments, pieces of vertebrae, and a malleolus. The diaphysis of one radius exhibits the same charred break pattern as is found in the deer metapodial from Area B. Additionally, some faint cuts are also noticeable in the charred area. This element and the tibia diaphysis both have well defined spiral fractures, whereas the other two fragments from these same elements seem to have been smashed or battered. Other than the charred edges, none is burned.

Features

Feature 1 is a hearth which yielded 2 identifiable bones out of 14 fragments. The elements identified are opossum ulna and pelvis.

Feature 2 consists of a large cluster of probable bison bones in area B. Approximately 200 fragments were removed from 8.2 m^2, 30 cm deep. Over ½ (120) of the fragments come from the upper level, level 3; 57 in level 4 and 25 in level 5. The feature is associated with a hearth (F-1) and Toyah focus artifacts as well as pottery sherds identified as Leon Plain (Figure 15.7-3).

Preservation of the osteological material ranges from fair to poor with some long bone diaphyses fairly well preserved and thinner elements, such as pelvis and scapula fragments, in poor condition. A mixture of 50% duco cement and 50% acetone was applied to the bones in the field as a stabilizer. The epiphyses of all of the identified long bones (except one) are crushed, gnawed, or battered into an extremely deteriorated state, prohibiting measurement. Furthermore, most of the proximal ends are deflated and distorted from the pressures of deposition. If complete measurements could be taken, then identification of the remains as bison could be made with more certainty. Cultural association and overall size strongly indicate *Bison bison* (cf. Jelks, 1962; Henry, 1980).

No complete vertebra were recovered at all and the scapulae are highly fragmented. No teeth, horn or cranial fragments were identified among the remains, and only one small medial rib fragment was found. The missing elements indicate that secondary butchering activities took place at this feature. According to many investigators, when Plains

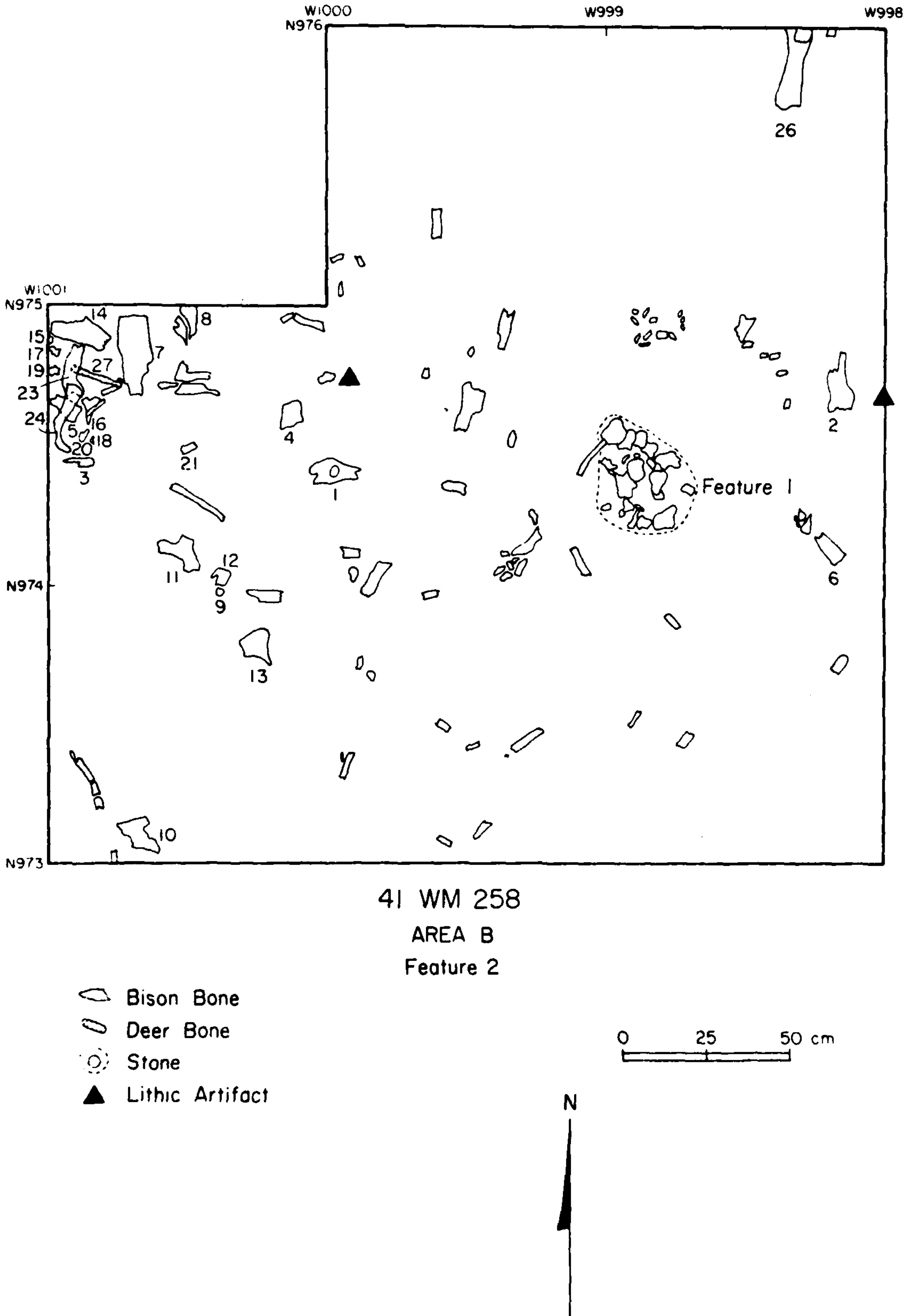


Figure 15.7-3. Bison Remains, Feature 2, 41WM258

Indians butchered a bison, they removed the choice meaty elements and wrapped them in the hide for transport to a cooking station. Usually the skull and vertebral column with proximal ribs attached were left at the kill site (White, 1953; Roe, 1951; McHugh, 1972). The hooves and caudal vertebrae were sometimes removed with the hide (Frison, 1974).

Butchering marks are not apparent on any of the elements. Cuts or chopping scars (if any) have been obliterated by chemical actions of the soil or by carnivore gnawing. An astragalus (Bone No. 15) has several grooved impressions on its medial surface similar to butchering cuts on astraguli as described by Gilbert (1969). Upon microscopic examinations, however, these marks are shallow, u-shaped grooves in groups of parallel pairs or trios going in three different directions, more like gnaw marks than cuts.

Many of the unidentifiable splinters have characteristic spiral fractures, and if preservation were better, evidence of splinter tool use might be detected. Frison shows photographs of butchered elements ("tibia choppers") with spiral fractures having been used (and found imbedded) to further butcher other elements from bison killed at the Casper Site (Frison, 1974; Fig 1.23). At any rate, the long bones from F-2 were undoubtedly cracked open (either by hacking and twisting or by chopping) to obtain the desired, nutritious marrow. None of these osteological elements are burned, indicating that the meat was stripped from the bones and either cooked immediately, preserved as pemmican or eaten raw (McHugh, 1972).

Three individuals are represented among the 27 identifiable elements by three right proximal femurs (Bone Nos. 11, 13, 25). Right scapulae rank next in frequency, then left scapulae, then left femurs (distal). Two different carpals were recovered but only one humerus and no recognizable cannon bones; many unidentifiable fragments may be smashed metapodials (cannon bones). Considering the amount of fragmentation relative to the minimum number assessment, there are not enough osteological remains for three individuals. Therefore, it is posulated that some type of cultural mechanism was employed to distribute body elements among members of the hunting party (McHugh, 1972). The members cooking at this hearth mainly received right fore and hindquarters.

Two non-bovine elements are identified in this feature (Nos. 18 and 27 on Figure 15.7-3). A squirrel mandible and loose incisor were found in the heaviest bone cluster in square N975/W1001. The element does not appear to be intrusive because (1) the preservation and stain are similar to the larger bones; and (2) fox squirrels do not burrow. The presence of this species suggests a dietary supplement of squirrel.

A complete diaphysis of a deer tibia was also found in the same cluster. It is the only deer-sized fragment from the feature. It is unburned like the bovine elements, but because it is the only deer element, its presence as food debris is doubtful. The singular squirrel element,

which is part of the usually discarded skull, is considered evidence as meal refuse because the remaining elements are small enough to be thoroughly masticated or disposed of elsewhere. On the other hand, a butchered and consumed deer should leave more refuse than one almost complete tibia. Both epiphyses of the tibia are missing and the distal end has been heavily gnawed, suggesting its use as a meat processing implement brought into the area, deposited, and attracting rodents as opposed to its being the lone refuse of a former meal at this feature. The surface of the tibia is too deteriorated to show evidence of use, and yet, whole or nearly whole deer elements are rare at any of the sites. Fluorine analysis could provide evidence that the deer bone was from earlier or later deposition than the bison within one year. This test is not complete and the results will not pinpoint the origin of the tibia nor its purpose. It is further possible that the 8 m^2 excavation area happened to miss refuse concentrations containing remains from other meals consisting of deer, squirrel and opossum.

Features 3 and 4 yielded no bone. The non-feature hearths and ash concentrations likewise contained no bone. It is conjectured that the osteological contents were either removed by the occupants when cleaning out the cooking hearths or have subsequently been scoured by floodings of Willis Creek.

Summary

Although several culture groups left evidence of their presence at Bigon-Kubala, the Toyah occupation is the most distinctive and intensive. A definite change in exploitative behavior is indicated by an absence of aquatic and woodland animals in the early component. Bison is another distincitive remnant of the Toyah people. No definitive evidence of this animal is found prior to their occupation.

Site 41WM267

Cervenka is an extensive terrace site at the base of an upland slope in the south central area of Granger Reservoir, approximately 4 km southwest of the dam. The San Gabriel river channel is now ½ km east of the site but was probably less than 200 m at the time of Archaic occupation. This close proximity provided accessible riverine exploitation.

Three major areas were excavated, all of which yielded some components with riverine faunas as well as upland prairie types. These remains suggest optimum utilization of the natural habitats surrounding the ancient encampments. A fourth area, a small test pit above a gravel bench (Area C), yielded only six bone fragments.

Of the major excavation areas, area A consisted of three cultural components designated as San Geronimo, Clear Fork, and San Marcos from

which a total volume of 10.6 m^3 of fill was removed, including approximately 5,000 pieces of bone. Area B contained four components, San Geronimo, Clear Fork, San Marcos and Twin Sisters. The volume from Area B was 12.6 m^3 with almost 10,000 fragments of bone recovered. The same components were found in Area D. Bone from this area was recovered in two field seasons, analyzed in three separated phases, and combined for this report. The resulting total bone from Area D approached 14,000 peices from a total volume of 41.4 m^3 of fill. Table 15.7-37 provides pertinent data for each component, combining excavation areas where the component occurs.

Calculations of bone debris density for each area reveals that Area B contained approximately 800 fragments per cubic meter, completed by dividing the total fragments recovered by total cubic meters of fill removed. Area A yielded 450 fragments per cubic meter, and Area D yielded only 333 per cubic meter. Overall density for Area D is low because of the large amount of sterile fill removed during two excavation phases, its great depth (7 m), and sacrificed overburden (unexamined fill) from the expanded units there. When bone debris density is figured for each component, however, the Clear Fork component at Area D alone yielded 1,262 per cubic meter which is due primarily to the 8 m^2 bone bed at the lower levels of this component (Feature 9).

A comparison of inter-area densities reveals which component was dominant in each area (Table 15.7-38). For example at Area A the Clear Fork component has the highest bone debris density, whereas the San Marcos component at Area B has a slightly greater density than the Clear Fork component below it. The San Geronimo components are consistently low in density which may be attributable to less intensive occupation or differential preservation. Likewise, these same variables, as well as damage caused by erosion, may have contributed to low densities for the Twin Sisters components at Cervenka. These relatively small samples do not allow for finer speculation.

A description of the faunal remains found in each component follows with illustrative tables at the end of this site description. Although this extensive site was minimally excavated, gross comparisons of the components (chronological analysis) and their areas (spatial analysis) should suggest broad patterns of exploitation based on the faunal remains.

San Geronimo

The oldest and deepest components are characterized by extremely poor preservation although identifiability (based on percentage of total bones identified from each component) is only slightly lower than other components (Table 15.7-38). In Areas A and B, rodent elements are prevalent, and although cotton rat remains rank highest in density at Area B (Table 15.7-39), rabbit and deer are undoubtedly more important there both in element count and minimum numbers. Deer and rabbit also figure prominently at Area B but are slightly overshadowed by the diversity and element counts of rodent species. Also note that a few reptile elements (mostly

TABLE 15.7-37. Faunal Summary for 41WM267

COMPONENT	TWIN SISTERS	SAN MARCOS	CLEAR FORK	SAN GERONIMO
AREAS	B Lv 2-6 D Lv 1-21	A Lv 2-13 B Lv 7-13 D Lv 2-36	A Lv 14-19 B Lv 14-25 C Lv 6-7 D Lv 2-8 Lv 47-66	A Lv 20-27 B Lv 26-32 D Lv 67-140
Vol. m^3	7.3	11.85	17.05	29.05
TOTAL BONE	770	6689	16548	4325
DENSITY/m^3	106	565	971	149
# ID	212	1455 (includes 1 invertebrate)	3263 (1=human)	928
% ID	28	22	20	22.2
MAMMALS	80%	70%	66%	71%
BIRDS	1%	1%	1%	1.7%
REPTILES	15%	27%	30%	25%
AMPHIBIANS	2%	1%	.5%	.6%
FISHES	2%	1%	3%	1.8%
TOTAL % BURNED	85/770 =11	849/6689 = 13	1797/16548 =11	495/+325 =12
ID % BURNED	3/212 =1.4	63/1450 = 4	173/3263 =5	74/924 =8

Table 15.7-38. Areal Distribution of Bone by Component, 41WM267.

AREA	COMPONENTS (Lvs.)	VOL. m^3	DENSITY	TOTAL BONE[a]	%ID	#ID
A	San Marcos (2-13)	5.2	345	1795	26	466
	Clear Fork (14-19)	2.4	855	2054	17	350
	San Geronimo (20-27)	3.0	297	891	18	159
B	Twin Sisters (2-6)	3.0	238	714	28	199
	San Marcos (7-13)	3.5	1209	4597	20	923
	Clear Fork (14-25)	4.8	977	4324	30	1290
	San Geronimo (26-32)	1.3	149	194	25	49
C	Unknown (1-5)	.6	-	-	-	-
	Clear Fork (6-7)	.9	6.6	6	-	-
D	Twin Sisters (1-21)	4.3	13	56	23.2	13
	San Marcos (2-36)	3.15	94	297	21.2	63
	Unknown (37-46)	1.1	23	26	23.1	6
	Clear Fork (47-66)	8.05	1262	10,164	16.0	1623
	San Geronimo (67-140)	24.75	131	3,240	22.2	720
BHT's	1978			486	18	89
	1979			424	23	98

[a] Includes feature bone.

snake vertebrae and turtle shell fragments) occur in all areas. Burned reptile elements are found only at Areas A and D, and none are burned at Area B. Roasted or raw, reptiles may have served as a food source. Cautionary assessment is required, because a high number of elements does not help determine their relative importance, because breakage (shell fragments) and the nature of repetitive elements, such as vertebrae and ribs (snakes), tend to inflate element counts. Furthermore these elements are not useful in minimum individual estimates.

Birds are found during this occupation only at Area D. Their remains are absent or unrecognized at the other areas. At Area D, furthermore, birds collectively account for 2% of all of the species represented during the San Geronimo occupation, and more avian elements were recovered there than from any other component at the site. Prairie chicken, turkey, and quail are important upland forms found here. One element from a species of Teal (Anas sp.) is the only evidence of waterfowl for this component.

Other aquatic fauna include pond slider turtle (Chrysemys/Graptemys group), soft-shell turtle (Trionyx sp.) musk/mud turtle (Kinesternidae), frog/toad spp. (Anurans), bullfrog (Rana catesbiana) and various fish species. All of the above, except for the Kinosternidae species, were recovered from Area D including at least three different species of fish (Table 15.7-40). Area A yielded only one catfish element and five other fish elements (one burned) but no other aquatic forms. Musk/mud turtle elements, likewise, are the only aquatic forms found at Area B. They are found there only during this occupation.

The San Geronimo components at Cervenka differ pointedly at each area. It is difficult to determine based on faunal remains whether any of the areas are chronologically related, and at which levels these relationships concurred. For example, does Area A represent a butchering station for people camped at Area D? From the small portions excavated at this large site, it is doubtful that these determinations can be ascertained from faunal remains.

Certain enigmatic observations are apparent between the areas containing San Geronimo material. Area D has the most varied identified faunas, the greatest number of elements and more minimum individuals per mammalian species, but it has the lowest density of bone per cubic meter for identified elements. Area A, however, has fewer species, not as many elements, and MNI of one for most mammals, but it has relatively high density per cubic meter. Area B has even fewer identified remains and only a dozen species represented, but it has high MNI's and densities per cubic meter.

The reason for low densities at Area D is because all of the matrix below elevation 95.60 and extending to the water table at approximately 92.30 was included in the volume figure used to compute those densities. Many of those levels contained very little bone. When the San Geronimo component at Area D is examined by level, some pattern of occupation is

Table 15.7-39. Total Number of Elements by Vertical Provenience, Site 41WM267.

Area A

SPECIES Lv.	SAN MARCOS 2-13	(T)	(B)	MNI	$5.2m^3$	CLEAR FORK 14-19	(T)	(B)	MNI	$2.4m^3$	SAN GERONIMO 20-27	(T)	(B)	MNI	$3.0m^3$
Rabbit	12	(7)	(3)	1	2.30	16	(5)	(7)	2	6.66	13	(5)	(3)	1	4.33
Jackrabbit	5	(1)	(1)	1	.96	3	-	-	1	1.25	7	(4)	(3)	1	2.33
Fox Squirrel											1	(1)	-	1	.33
Ground Squirrel	2	(2)	-	1	.38	2	(2)	-	1	.83					
Pocket Gopher	55	(33)	(2)	4	10.57	16	(9)	-	2	6.66	6	(2)	-	1	2.00
Pocket Mouse	3	-	-	1	.57	2	(2)	-	1	.83	2	(1)	-	1	.66
Grasshopper Mouse											1	-	-	1	.33
Deer Mouse	1	-	-	1	.19	2	(1)	-	1	.83	2	-	-	1	.66
Cotton Rat	40	(23)	(1)	4	7.69	37	(18)	-	3	15.41	18	(9)	(2)	2	6.00
Woodrat	1	-	-	1	.19	1	(1)	-	1	.41	3	(3)	-	1	1.00
Vole	14	(6)	-	3	2.69	2	(1)	-	1	.83	1	(1)	-	1	.33
Dog sp.	5	(1)	-	1	.96	3	(3)	-	1	1.25	5	(3)	-	1	1.66
Deer	50	(35)	(1)	2	9.61	81	(44)	(5)	2	33.75	14	(12)	-	1	4.66
cf. Pronghorn											3	(3)	-	1	1.00
Rodent	119	(46)	(3)		22.88	52	(23)	(1)		21.66	39	(21)	(3)		13.00
Medium mam.	9	-	-		1.73	5	-	(1)		2.08	1	-	(1)		.33
Large mam.	2	(2)	(1)		.38	12	(12)	-		5.00					
Bird sp. medium	3	-	-		.57										
Prairie Chicken	2	-	-		.38										
Snake sp.	19	-	(2)		3.65	12	-	-		5.00	13	-	(1)		4.33
Viper	16	-	(1)		3.07	22	-	(4)		9.16	4	-	-		1.33
Colubrid	72	-	(2)		13.84	32	-	(3)		13.33	11	-	-		3.66
Hog-nosed Snake	1	-	-		.19	2	-	-		.83					
Turtle sp.	15	-	(8)		2.88	31	-	(8)		12.91	8	-	-		2.66
Pond Slider						3	-	-		1.25					
Box Turtle	1	-	-		.19										
Lizard sp.	5	-	-		.96						1	-	-		.33
Frog sp.	6	-	-		1.15	1	-	-		.41					
Salamander sp.	2	-	-		.38										
Fish sp.	6	-	-		1.15	12	-	(2)		5.00	5	-	(1)		1.66
Catfish						1	-	-		4.1	1	-	-		.33
TOTAL ID	466					339					159				

(T)= No. of teeth included in total. (B)= No. of burned elements included in total.
m^3= Volume excavated and element density per taxon.

Table 15.7-39. Total Number of Elements by Vertical Provenience, Site 41WM267.

Area B

SPECIES Lv.	TWIN SISTERS 2 - 6	(T)	(B)	MNI	$3.0m^3$	SAN MARCOS 7 -13	(T)	(B)	MNI	$3.5m^3$	CLEAR FORK 14-25	(T)	(B)	MNI	$4.8m^3$	SAN GERONIMO 26-32	(T)	(B)	MNI	$1.3m^3$
Opossum	1	-	-	1	.33															
Least Shrew											2	-	-	1	.41					
Rabbit	1	-	-	1	.33	28	(6)	(2)	2	8.00	37	(15)	(2)	3	7.70	12	(2)	(1)	3	9.23
Jack rabbit						10	(1)	(1)	2	2.57	16	(5)	(2)	3	3.33	2	-	-		1.53
Fox Squirrel						1	(1)	-	1	.28										
Ground Squirrel						9	(8)	-	1	2.57	12	(10)	-	1	2.50					
Pocket Gopher	19	(10)	-	2	6.33	138	(97)	(3)	8	39.42	91	(52)	(2)	9	18.95					
Pocket Mouse	5	(1)	-	2	1.66	29	(9)	(1)	6	8.28	22	(4)	-	4	4.58					
Beaver						1	(1)	-	1	.28	1	(1)	-	1	.20					
Harvest Mouse	1	-	-	1	.33	2	(1)	-	1	.57	3	-	-	1	.62					
Deer Mouse	2	-	-	1	.66	6	-	(1)	3	1.71	7	(1)	-	1	1.45					
N. Grasshopper Mouse											1	-	-	1	.20					
cf. N. Pygmy Mouse						2	-	-	1	.57										
Cotton Rat	48	(14)	-	6	16.00	51	(37)	(1)	3	14.57	133	(57)	(1)	9	27.70	15	-	(1)	2	11.53
Woodrat	7	(2)	(1)	1	2.33	4	(2)	(1)	1	1.14	3	-	(1)	1	.62	1	-	-	1	.76
Vole	1	-	-	1	.33	23	(14)	-	2	6.57	8	(1)	-	1	1.66					
Dog sp.						5	-	-	1	1.42	6	(2)	(1)	1	1.25	3	-	-	2	2.30
Raccoon						3	(2)	-	1	.85	1	-	-	1	.20					
Badger						3	(2)	-	1	.85										
Deer	27	(15)	-	2	9.00	88	(35)	(6)	3	25.14	101	(34)	(8)	3	21.04	7	(1)	(1)	2	5.38
cf. Pronghorn						1	(1)	-	1	.28	17	(15)	(1)	1	3.54					
Rodent	46	(11)	(1)		15.33	222	(57)	(3)		63.42	279	(88)	(18)		58.12	1	-	-		.76
Small mam.	1	-	-		.33						6	-	(4)		1.25					
Medium mam.						23	(4)	-		6.57	25	(3)	(5)		5.20					
Large mam.						1	(1)	-		.28	25	(21)	-		5.20					
Bird sp. small											1	-	-		.21					
Bird sp. medium						5	-	-		1.43	2	-	-		.42					
Bird sp. large											4	-	(2)		.83					
cf. Teal						1	-	-		.28										
cf. Eagle											1	-	-		.21					

Table 15.7-39. Total Number of Elements by Vertical Provenience, Site 41WM267, continued.

Area B -continued

	TWIN SISTERS					SAN MARCOS					CLEAR FORK					SAN GERINOMO				
SPECIES Lv.	2 - 6	(T)	(B)	MNI	3.0m³	7-13	(T)	(B)	MNI	3.5m³	14-25	(T)	(B)	MNI	4.8m³	26-32	(T)	(B)	MNI	1.3m³
Hawk sp.						1	-	-		.28										
Prairie Chicken	1	-	-		.33						1	-	-		.21					
Bobwhite						1	-	-		.28										
Perching Bird sp.						3	-	-		.85										
cf. Lark Sparrow	1	-	-		.33						2	-	-		.42					
Snake sp.	7	-	-		2.33	17	-	-		4.85	57	-	(1)		11.88					
Viper						43	-	-		12.29	99	-	(4)		20.62	2	-	-		1.54
Colubrid	13	-	-		4.33	142	-	-		40.57	148	-	(6)		30.83	2	-	-		1.54
Hog-nosed Snake						1	-	-		.23	4	-	(1)		.83					
Turtle sp.	5	-	-		1.67	15	-	(4)		4.28	48	-	(11)		10.00	1	-	-		.77
Pond Slider						1	-	-		.28	6	-	(6)		1.25					
Box Turtle						1	-	-		.23						1	-	-		.77
Musk/Mud Turtle																2	-	-		1.54
Softshell Turtle											3	-	-		.625					
Lizard sp.	4	-	-		1.33	22	-	-		6.29	53	-	-		11.040					
Frog sp.	5	-	-		1.67	9			2	2.29	12				2.29					
Bullfrog						1				.28	1				.21					
Salamander sp.						2	-	-		.57	2	-	-		.42					
Fish sp.	3	-	-		1.0	8	-	-		.22	43	-	(1)		10.0					
Gar	1	-	-		.33						1	-	(1)		.21					
Catfish											1	-	-		.21					
Crayfish						1	-	(1)		.28										
TOTAL ID	199					924					1290					49				

(T)= No. of teeth included in total. (B)= No. of burned elements included in total. m³= Volume excavated and element density per taxon.

Table 15.7-40. Total Number of Elements by Vertical Provenience, Site 41WM267.

AREA D*

	TWIN SISTERS					SAN MARCOS					CLEAR FORK+					CLEAR FORK (Feature 9 only)					SAN GERONIMO				
SPECIES	Lv. 1-21	(T)	(B)	MNI	4.3 m^3	22-36	(T)	(B)	MNI	3.15m^3	47-66	(T)	(B)	MNI	8.05m^3		(T)	(B)	MNI	.8m^3	67-140	(T)	(B)	MNI	24.75m^3
Opossum											1	-	-	1	.1						3	-	-	1	.1
Rabbit						2	(2)	-	1	.6	49	(10)	(1)	3	6.1	11	(4)	(1)	2	13.8	52	(16)	(4)	5	2.1
Jackrabbit						2	-	-	1	.6	39	(1)	(1)	3	4.8	17	(1)	-	2	21.3	35	(4)	(8)	3	1.4
Fox Squirrel						1	-	(1)	1	.3											1	-	-	1	
Ground Squirrel											1	-	-	1	.1										
Pocket Gopher						2	-	-	1	.6	59	(45)	(4)	2	7.3	4	(4)	-	1	5.0	22	(3)	(1)	2	.9
Pocket Mouse											4	(1)	-	1	.5						8	(1)	-	6	.3
Deer Mouse																					2	-	-	1	
Grasshopper Mouse											1	-	-	1	.1	1	-	-		1.3					
Harvest Mouse																					7	-	-	3	.3
Cotton Rat						1	-	-	1	.3	69	(28)	(1)	3	8.6	36	(13)	-	2	45.0	61	(12)	-	6	2.5
Woodrat											6	(1)	-	1	.7	2	-	-	1	2.5	22	(6)	(1)	3	.9
Vole											2	(2)	-	1	.2	1	(1)	-		1.3					
Dog sp.											29	(11)	(1)	1	3.6	14	(5)	-		17.5	29	(10)	(4)	2	1.2
Coyote											8	(2)	-	1	1.0						5	(4)	-	1	.2
Raccoon											3	(1)	-	1	.4						3	(1)	-	1	.1
cf Mink						1	-	-	1	.3															
Badger											2	(1)	-	1	.2	1	-	-	1	1.3					
Skunk																					1	(1)	-	1	
Bobcat																					1	-	-	1	
Puma																					1	-	-	1	
Deer	3	-	-	2	.7	7	(3)	(2)	1	2.2	505	((166)	((12)	3	62.6	311	(81)	3	5	388.0	70	(24)	(8)	3	2.6
Pronghorn						1	-	(1)	1	.3	50	(38)	(4)	2	6.2	9	(7)	-	1	11.3	24	(21)	(2)	2	1.0
Cow/Bison																					15	-	-	2	.6
Rodent	1	-	-		.2	1	-	-		.3	83	(32)	(3)		10.3	21	(9)	(1)		26.3	73	(26)	(1)		3.0
Small mam.						1	-	(1)		.3	13	-	-		1.6	13	-	-		16.3	5	-	-		.2
Medium mam.	1	(1)	-		.2	4	-	-		1.3	22	(2)	-		2.7	12	-	-		15.0	13	-	(1)		.5
Artiodactyl	5	(4)	(1)		1.2	19	(1)	(7)		6.0	144	(55)	(7)		17.9	12	(10)	-		15.0	47	(2)	(9)		1.9
Bird sp.																					5	-	-		.2
Duck sp.											1	-	-		.1	1	-	-		1.3					
Teal											2	-	-		.2		-	-			1	-	-		
Quail																					1	-	-		
Turkey																					1	-	-		
Prairie Chicken											9	-	-		1.1	7	-	-		8.8	6	-	-		

*Lvs. 37-46 are omitted as a relatively sterile zone. +Includes F-9

Table 15.7-40 Total Number of Elements by Vertical Provenience, Site 41WM267, continued.

AREA D* continued

	TWIN SISTER					SAN MARCOS					CLEAR FORK+					CLEARFORK (Feature 9 only)					SAN GERONIMO				
SPECIES Lv.	1-21	(T)	(B)	MNI	4.3m3	22-36	(T)	(B)	MNI	3.15 m3	47-66	(T)	(B)	MNI	8.05 m3		(T)	(B)	MNI	.8m3	67-140	(T)	(B)	MNI	24.7 m3
Owl sp.											2	-	-		.2		-	-			1	-	-		
Passeriformes											1	-	-		.1		-	-							
Robin																					1	-	-		
Snake sp.						2	-	-		.6	74	-	(3)		9.2	45	-	-		56.3	22	-	(4)		.9
Viper						2	-	-		.6	140	-	(4)		17.4	58	-	-		72.5	51	-	(3)		2.1
Colubrid	2	-	-		.5	5	-	(1)		1.6	154	-	(3)		19.1	68	-	-		85.3	43	-	(2)		1.7
Hog-nosed snake																					1	-	-		
Rat snake																					1	-	-		
Water snake											1	-	-		.1										
Turtle sp.	1	-	-		.2	7	-	(3)		2.2	55	-	(9)		6.8	18	-	1		22.5	49	-	(2)		2.0
Box turtle						4	-	-		1.3	19	-	(2)		2.4		-				9	-	(4)		.4
Pond slider						1	-	-		.3	9	-	(1)		1.1	4	-	-		5.0	6	-	(1)		.2
Musk/mud turtle											10	-	(4)		1.2		-								
Soft-shell turtle											8	-	(1)		1	1	-	-		1.3	2	-	-		
Lizard sp.											1	-	-		.1	1	-	-			2	-	-		
Toad/frog sp.											2	-	-		.2	1	-	-		1.3	4	-	-		.2
Bullfrog											1	-	(1)		.1		-				2	-	-		
Fish sp.											35	-	(1)		4.4	23	-	-		28.7	5	-	-		.2
Gar											4	-	-		.5	1	-	-		1.3	4	-	-		.2
Catfish											5	-	-		.6	1	-	-		1.3	1	-	-		
Bass/perch																					2	-	-		
TOTAL ID	13					63					1623					694					720				

(T)= No. of teeth included in total.
(B)= No. of burned elements included in total.
m3= Volume excavated and element density per taxon.

observable. This pattern is characterized by clusters of burned bone, occurrences of bone tools, and the presence of certain species not found in other levels (Figure 15.7-4). For example, bison occur only in the lower levels where there is a concurrent rise in total bone fragments and the presence of bone tools. The middle levels contain the greatest variety of species, the most bone fragments, and more bone tools. Pronghorn, dog and fish species occur only in the uppermost levels of the San Geronimo component. These three sets of levels are separated by levels with lower frequencies of total bone and burned bone as well as fewer species.

The bison bones were recovered during the second season's excavation when new squares were opened and extended below the previous season's work. They occur exclusively below elevation 93.80 to 93.1. Within the zone, 15 elements were recovered and identified as bison. Identification is based primarily on size and morphological characteristics of the elements.

Most of the elements are vertebral spinous processes or rib fragments. No teeth were recorded. Three elements were suitable for limited measurements. A proximal radius fragment from square E-5 (Feature 26, 93.30 m) has as its maximum width 90 mm and breadth of 49 mm. According to Duffield's research (1970), these measurements correspond to the general range of male bison, aged 3 to 7 years or fully mature adult male. The accompanying ulna is usually firmly fused to the radius at this age, but no ulna fragments are recorded.

An unfused femur head (proximal epiphysis) was recovered from square E 10 (93.00 m) and indicates a juvenile individual. It is somewhat damaged around the edges but measures no less than 59 mm in width and 47 mm in breadth. This animal could be no older than 6 mos. According to most sources (Hornaday 1887, Grinnel 1904, Roe 1951, Caras 1967), calves are born in late spring to early summer. Therefore, the presence of this young bison indicates at least a winter occupation for this zone.

The third measurable element poses some identification problems. It is the acetabulum area of a right innominate (pelvis), fully fused but lacking well-developed muscle scars (Fig. 15.7-5). Diagnostic areas such as the <u>tuber ischia</u> on the ischium are not present (see Olsen 1960). This element compares well with, if not slightly smaller than, a modern domestic cow; yet it is too large for deer or elk. It was recovered from square E 5 at 93.60 m. and is tentatively identified as a small, sub-adult female bison. Measurements are given in Fig. 15.7-5.

Based on the elevations, locations, and identification of these elements, three individual bison are suggested for the San Geronimo levels. They were probably abundant year round in the upland prairie. The Berlandier manuscript comments against the notion of extensive migration for the southern herds:

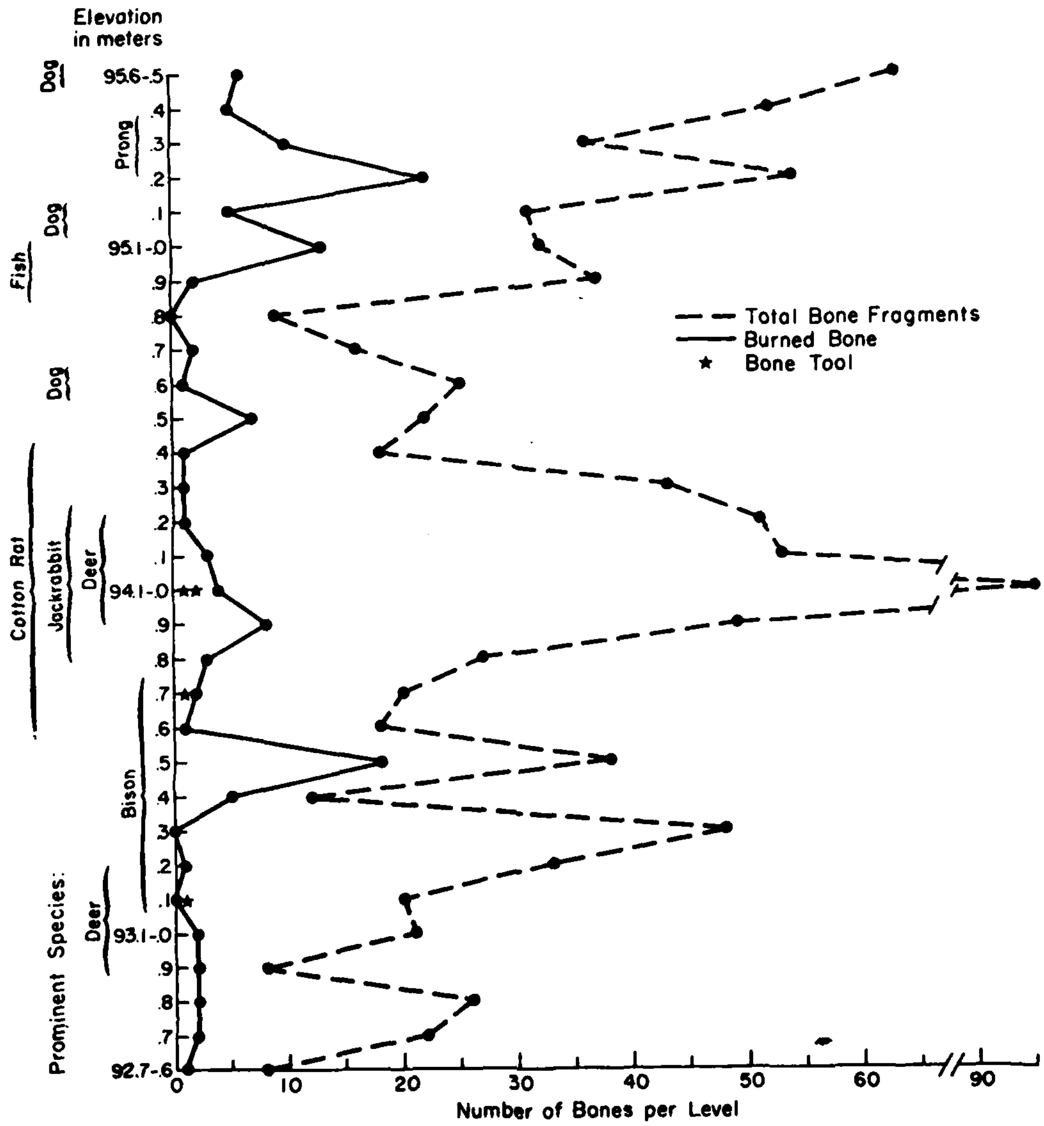
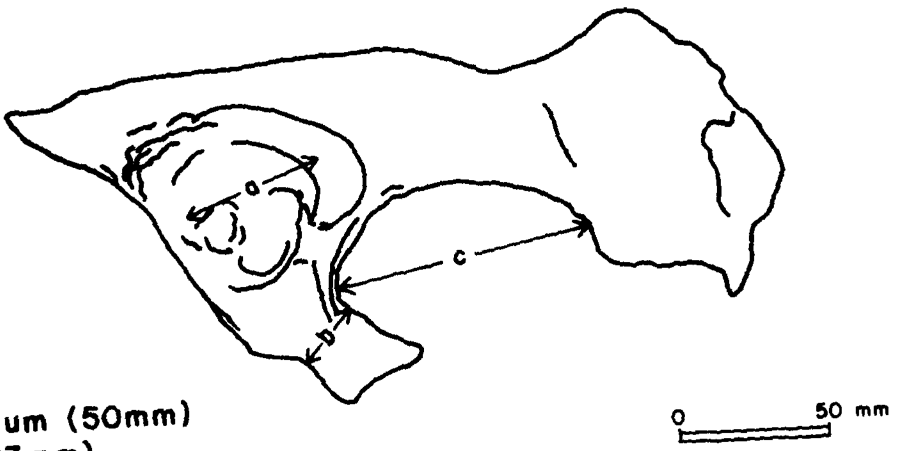


Fig. 15.7-4. Frequency of Bone for San Geronimo Component, 41WM267.



a - Acetabulum (50mm)
b - Pubis (23mm)
c - Obturator Foramen (87.5mm)

Figure 15.7-5. Large mammal pelvis from San Geronimo Component, 41WM267, and selected measurements.

> These migrations are not general, for certain bands do not seem to follow the general mass of their kin, but remain stationary throughout the whole year on the prairies covered with a rich vegetation on the banks of the Rio de Guadeloupe and the Rio Colorado of Texas, not far from the shores of the Gulf.
>
> (from Roe, 1951)

The Colorado River flows less than 48 km (30 miles) south of Williamson Co. today. Therefore, bison are historically documented near the San Gabriel sites. Furthermore, there is no reason to doubt their year-round presence c. 5000 years BP. Because bison remains are relatively sparse at this site, one may tenuously infer that the human hunters occupied the site as a small band lacking sufficient organization to conduct large-scale bison hunting. Absence of teeth and feet elements argues against interpreting the activity as a kill/butchering station.

In summary, the San Geronimo components at Cervenka yielded relatively little faunal material. It is important to note that this component contained the only evidence for bison at the site. Although bison remains number less than 20 elements, they represent three adult individuals. Aquatic forms are present, but prairie forms are more numerous in the assemblages. Rodent species collectively account for almost 20% of the identified remains. Some elements of pocket gopher and cotton rat are burned. Deer is present, but constitutes only 9% of the identified elements while rabbits contribute 12%. Animal resources for the San Geronimo component werevaried but probably based primarily on bison.

Clear Fork

The Clear Fork components provide more bone than any other component at Cervenka. A total of 16,548 bonefragments were submitted for analysis. Twnety per cent (3,264 elements) were identified and 11% of the total were recorded as burned. A total of approximately 17 cubic meters of fill was excavated from levels designated as Clear Fork components from all four excavated areas of the site. Bone density was computed at 971 fragments per cubic meter, the highest density for any cultural component at 41WM267.

The composition of the Clear Fork fauna is expectedly dominated by mammals (66%) and secondly, reptilian remains (30%). Fish comprise 3%, birds 1%, and amphibians only 0.5%. These figures approximate the composition of faunal remains from the other components at Cervenka (Table 8.5-36).

Taken as a whole,the diversity of species from the Clear Fork levels is high (Table8.5-G). Nineteen mammalian taxa are identified including one marsupial, one insectivore, two lagomorphs, ten rodent genera, three carnivores and two artiodactyls. Bison are not represented.

Reptiles consist of both poisonous and nonpoisonous snakes. Two nonpoisonous genera are determinable, i.e., one species of water snake (Natrix sp.) and one individual hognose snake (Heterodon sp.). Three aquatic turtles and one land turtle (Terrapene sp.) are recognized. Unspecified lizard remains complete the reptilian assemblages.

Fish vertebrae are abundant in this component. Most are small in size suggesting species such as sunfish (Lepomis sp.) or shad (Dorosoma sp.). The only genera positively identified are gar and catfish. The gar vertebrae are from small species, probably spotted or longnose gar (Lepisosteus oculatus or L. osseus). Catfish elements are generally too broken to determine exact species; furthermore, almost all of the Ictaluridae found in Texas occur in Williamson Co. waters today.

Avain species include waterfowl, raptors, and small perching birds as well as an abundance of prairie chicken remains. Several elements are obviously avain but can only be classified into size categories as representing large (e.g., hawk), medium (e.g., prairie chicken), or small birds (e.g., sparrows).

Amphibians are represented by both anurans and urodeles: The only readily identifiable anuran species is bullfrog, but other smaller species of toads and frogs occur as well. The salamander remains are of substantial size and probably come from members of the genus Ambystoma, many species of which are current natives to Williamsono County.

Vertebrates are not evenly distributed between the areas that contain Clear Fork material. Most are found at Area D and none are identified at Area C, where only six bone fragments were recovered from a feature in that small test pit. Area B has a similar complement of animals as Area D but at greater densities for most taxa on a cubic meter basis. Area A has no bird remains, one amphibian element, and relatively small quantities of reptiles and fish. Compare species lists in Tables 15.7-38 and 15.7-39.

The mammalian assemblages for this component at each area are dominated by high densities of deer and rodents with cotton rat and pocket gopher remains again prevalent. Cottontail rabbit, jackrabbit, and ground squirrel are moderately represented at all three areas. Dog remains also occur at all three excavation areas, although only dental elements are recorded from Area A. The exact species of Canis is indeterminable because of the fragmentary nature of the elements. Area D, however, produced a few elements that more closely resemble coyote than the Indian burial dog specimen (from Cooper Lake, 41HP34) used for comparison purposes in the identification phase. Only one canid element (a proximal radius fragment) is burned and that comes from Area B.

Area B also yielded the only remains of least shrew (Cryptotis parva) found at Cervenka. Two elements were recovered from the Clear Fork component. The only other occurrence of this species at Granger is from upper levels at Loeve-Fox. This species co-exists with cotton rats,

generally burrows less than ten inches below ground surface, and is hard to trap except during winter when their own food supply is low (Davis 1974). It might have provided an available morsel but is probably intrusive.

Area D has remains of badger, which is unrecorded form this component in the other excavation areas. Basically the badger is a nocturnal carnivore currently ranging west of Williamson Co. but probably inhabited upland prairies near Cervenka in the past. Although ferocious, badgers can be lured from their dens by using smelly fish bait (Caras 1967).

Two other mammals deserve mention since their remains link Areas B and D in common. Remains of raccoon and pronghorn occur at both areas in Clear Fork levels but not at Area A. Pronghorn teeth fragments further attest to use of the upland prairie while capture of raccoon generally occurs in riparian bottomlands or higher woodlands close to a water source. Only one individual of each was recovered from the excavations at both areas. Again exploitation of both prairie and forest are indicated.

Minimum numbers of deer are relatively high considering the small areas excavated. At least two deer are recorded for the Clear Fork levels at Area A and three are estimated at Area B and five at Area D. The deer elements from all areas are primarily "waste" bones. Very few elements from meaty portions of the carcass are recognizable in the assemblages. However, the unidentifiable bone debris contains long bone splinters, suggesting intentional fracturing, and there is a clear absence of the sturdy distal ends of long bones such as tibiae, radii, and humeri. This may infer that the meat was consumed and the corresponding meal refuse was discarded outside the excavated area, with one notable exception.

The exception is found at Area D where a large bone bed (2 x 4 meters) was exposed at the lower levels of the Clear Fork component. Forty-eight percent of the component bone at Area D comes from this feature (F-9). The element composition is radically different from the non-feature bone here and at the other two excavation areas (Areas A and B). All body parts of deer are found in the feature as well as bone tools and an abundance of lithic artifacts, freshwater mussels, and snail shells (Fig.15.7-6). The greatest concentration of deer bone is adjacent to a large cluster of burned limestone and charcoal. Many fragments from meaty bones are located near this hearth.

Table 15.7-40 lists the number of elements per taxon and the density per cubic meter for each animal identified from Feature 9. The column labeled "Clear Fork" reflects all of the identified material, including F-9, and it is apparent that the majority of several taxa was recovered from the feature. A few mammals are not represented in the feature bone, namely opossum, ground squirrel, pocket mouse, and raccoon. They are present in very low frequencies outside the feature and, therefore, may be incidental in occurrence.

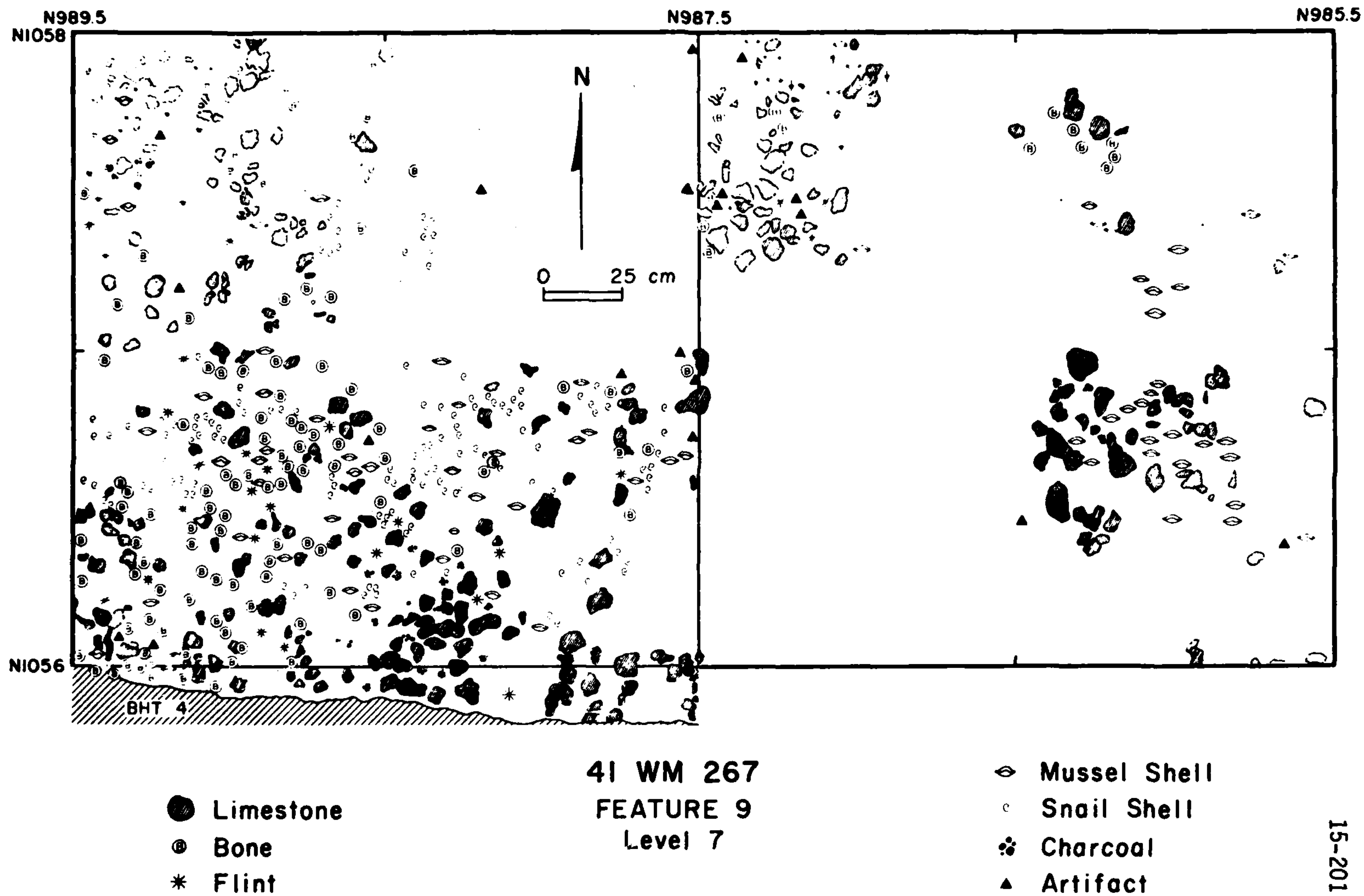


Figure 15.7-6. Clear Fork bone bed (Feature 9) from Cervenka, 41WM267.

The concentration of the other animals in the feature is evident from high densities, even though slightly less than a cubic meter was involved in the feature fill (.8 m^3). For example, total deer remains amount to 62.6 elements per cubic meter for the entire Clear Fork component at Area D, but the feature contained 388 deer elements on a comparable cubic meter basis. In fact, 62% of the Clear Fork deer elements at Area D were recovered from this larger feature. A conservative MNI for deer is estimated at five individuals from the feature and three from the non-feature material. This estimate is based on the most frequently occurring element, that is, three left proximal ulnae for the non-feature bone and three unfused proximal femurs plus two adult ulnae from the feature material. . Using the greater estimates, five individuals are recorded for the entire component at Area D. Unfortunately, estimations of MNI lose utility when units of analysis are subdivided (Grayson 1973; Munson and Limp, n.d.).

Determination of minimum numbers of deer is confounded by the poor preservation of the Clear Fork bone. The elements are badly fragmented and deteriorated to the point that differentiation between deer and pronghorn is impossible even for those elements that are ordinarily diagnostic. Therefore, many elements were discounted from MNI assessment and relegated to the "artiodactyl" category.

Expectedly, these large mammals contributed the major portion of the diet for the Clear Fork component. Despite problems in distinguishing one from the other in this assemblage, identifiable deer elements far outnumber those of pronghorn, therefore, suggesting a greater utilization of the woodlands for large game. Non-mammals (especially aquatic taxa) are abundant, but the extent of their utilization is difficult to determine. Prairie chicken remains are the most numerous avian form, and yet, woodland turkey is not represented at all. The fauna from the Clear Fork component at Cervenka suggest active utilization of all available habitats: woodland, riparian, and upland prairie.

Round Rock

No Round Rock assemblages were recovered from Cervenka.

San Marcos

The San Marcos component at Cervenka yielded more identifiable bone than the same component from any other site investigated (Table 8.5-E). Over 1,400 identified elements from 36 taxa were analyzed out of a total of approximately 6,600 bones recovered from the three major excavation areas. Preservation is fair to good although most elements are quite fragmentary. Thirteen per cent of the total are burned, which marginally ranks this component highest for the site in frequency of burned bone (Table 15.7-37). In overall density, this component ranks second to Clear

fork with a combined area density figure of 565 bones per cubic meter. As seen in the other components, mammalian remains are the most common vertebrae class identified.

Of all the mammals, rodents are represented in greatest frequency and highest denisty. However, it should be apparent from the area species lists (Table 15.7-39) that the majority of elements assigned to each rodent genera are loose teeth, therefore, skewing the frequency of occurrence. The category of unspecific rodent/small mammal elements has the highest frequency and contains elements that could not be confidently assigned to a specific rodent genera (Table 15.7-E).

Reptilian remains rank next in frequency. Colubrid (nonpoisonous) snake vertebrae and ribs are numerous from all three excavation areas. Very few of these elements are burned and their attribution as food items is questionable.

Despite inflated frequencies for rodents and snakes, deer was undoubtedly the primary source for meat. Ten percent of all the identified elements from the San Marcos components at Cervenka are deer.

Small and medium-sized mammals undoubtedly supplemented the protein source in the form of cottontail rabbit and jackrabbit as well as beaver, badger, raccoon, and dog. Remains of the lagomorphs are more prevalent at Area B where at least two individual cottontail rabbits and two jackrabbits are recorded. They are present in the sample from Area A, however, in lower density. Evidence of beaver, raccoon, and badger is found only at Area B and suggests utilization of both riparian and prairie habitats by the San Marcos occupants. Pronghorn are represented, but only one tooth (Area B) and a carpal (Area D) are positively identified. No bison remains are recorded. Many of the unspecific large mammal fragments show indications of intentional fracturing for marrow extraction. A minimum of two deer is estimated for both Areas A and B, but only one individual is apparent at Area D. More than half of the deer elements at Area A are loose and fragmentary teeth while Area B has more complete evidence of two adult deer and one fawn, indicating at least a spring/late summer occupation.

An attempt was made to find a link between the San Marcos deer remains at Areas A and B by utilizing Romuald Schild's concept of an "articulation net" to determine if flint blanks can be matched with cores found spatially separated. Lyman (1980) adapted the concept for faunal analysis to test the hypothesis of kill sharing/redistribution patterns between two areas by trying to match broken bone fragments. Any articulation of two fragments (one from each area) would increase the probability of correlation between the areas. A cursory examination of 100 fragments (50 large mammal fragments over 2 cm long from each area) revealed no "fits." Differential preservation is thought to be a prohibitive factor in this assessment.

Dog remains occur at both areas and consist primarily of feet bones (phalanges and metapodials). An adult premolar fragment is recorded from Area A and appears to be from a rather young individual because the tooth exhibits little attrition. There are not enough elements to suggest intentional burial nor are there any burned elements to suggest that dogs were roasted as food. The nearly exclusive presence of feet elements of fur-bearing animals can suggest two possibilities: (1) the feet were retained with the hide after skinning and tanning, in which case their presence indicates a disintegrated fur piece, or (2) the feet were discarded after tanning process then becoming part of normal hide-processing refuse and deposited separately from the rest of the carcass. Therefore, these canid remains may have resulted from the use of dogs as clothing sources instead of food.

Evidence for aquatic resource utilization is found in the presence of frog, salamander, fish, and waterfowl (Teal sp.) remains. While not abundant, in part because of their delicate nature, the presence of elements from these taxa strongly suggests utilization of water-related fauna. The fish remains are from small species such as sunfishes or shad, and therefore, indicate a nearby marsh/small stream habitat. Few aquatic turtles and larger fish species (e.g., gar and catfish) are recorded from this component. This may indicate wetlands with only an intermittent stream unsuitable for these taxa at the time of occupation. The identified animals are most active during spring while spawning, thereby enhancing procurement by the site's occupants. Incidentally, a burned crayfish pincer is recorded from Area B, which further suggests a spring occupation for this component.

Just as waterfowl remains suggest wetlands, other avian remains suggest utilization of the uplands. Evidence of prairie chicken is found at Area A and bobwhite quail at Area B. No bird bones are recorded for this component from Area D. Likewise, Area D yielded no evidence for aquatic turtles, amphibians, or fish during its San Marcos occupation.

Twin Sisters

Cultural debris associated with Late Archaic (Twin Sisters) occupation occurs only in Area B and possibly Area D at Cervenka. A combined volume of 7.3 m^3 from these excavation areas is designated as Twin Sisters and contains 770 fragments of bone or a density of 106 per cubic meter, which is the lowest density computed for all of the Cervenka components (Table 14.7-37). The percentage of burned bone (11%) is similar to the other component, and preservation of the bone is also similar to the older material although surficial pitting is diminished somewhat.

All vertebrate classes are represented in this small sample of identified fauna consisting of 212 elements from the combined areas. Mammals predominate as in the other components with rodent remains again quite numerous (Table 15.7-D).

Deer remains comprise 14% of the sample. Two young deer are estimated at Area B, one of which was less than three months at death. Only three deer bones were recovered from Area D. However, a minimum of two individuals are indicated by one adult-sized phalanx and two deciduous molars. The fawn from Area B may be the same as the one at Area D, however, not enough material was recovered to perform "articulation net" investigations to determine intrasite relations based on deer remains.

Based on species diversity, the two areas are quite dissimilar. Twenty-one taxonomic categories are used for the identified fauna from Area B while only six categories are required for the sample from Area D (Tables 15.7-39 and 15.7-40). In fact, only 56 fragments of bone were recovered from levels at Area D which are cautiously designated by the excavators as a Twin Sisters occupation zone.

The identified fauna from Area B, therefore, is considered more useful here to characterize the Twin Sisters occupation. Like the other components, rodent and deer remains occur in greatest frequency with deer as the primary meat source and most rodents (e.g., cotton rat, deer mouse, and pocket gopher) suspected as intrusive. One woodrat element, however, is burned.

The absence of prairie forms that are present in the other components may be significant in making evaluations of the prehistoric environment and its utilization by early hunter/gatherer groups. For example, jackrabbit, badger, pronghorn and bobwhite are not recorded for this component at either Area B or Area D. Only one element identified as prairie chicken (from Area B) suggests either minimal upland exploitation or a climatic change characterized by increased moisture and spreading of the woodlands. The arboreal opposum, for example, is represented once again during this phase at Cervenka, its last appearance occurring in the Clear Fork assemblage. Aquatic fauna do not increase in diversity or frequency; however, they are present at Area B as unspecified fish, gar and frogs. The absence of aquatic turtles in the faunal remains disturbs this concept of increased moisture, but does not interfere with the notion of reduced upland exploitation.

Features

A total of 28 features were designated during the two excavation periods at Cervenka. Of these, 17 features contained bone and were submitted for faunal analysis. All of the features are associated with Archaic artifacts: eight from San Geronimo levels, five from Clear Fork levels, three from San Marcos levels, and one of unknown affiliation. Despite the number of features yielding bone, 90% of the total feature faunal remains come from the Clear Fork bone bed at Area D (Feature 9). The remaining features yielded an average of 65 bone fragments ranging from 3 to 380 pieces in a feature.

Excluding the bone bed, extremely poor preservation resulted in even lower percentages of identified fauna. Most of these features have no

identifiable animal bones, and few fragments show evidence of burning. There is evidence to suggest extensive natural disturbance (scouring, scavenging) in most of the features resulting in scarcity of faunal remains. Out of the 6,000 fragments recovered from features, 12% are identifiable to some degree, generally representing the same animals found in non-feature matrices. The discussion of the faunal remains from these features is given in numerical order for easier cross reference with the chronological description in the archaeology section.

Feature 1 (Area C) Burned rock cluster, Unkonwn cultural affiliation.

No bone was recovered.

Feature 2 (Area D, BHT) Basin-shaped hearth. San Geronimo.

Five fragments were recovered, but none identified.

Feature 3 Area C) Living floor. Clear Fork.

Six fragments were recovered, two of which are burned. None are identified.

Feature 4 (Area B) Living floor. San Marcos.

Almost 400 fragments were recovered from the hearth and surrounding litter of this early San Marcos feature. Despite the density of bone refuse, only three elements are preserved well enough to be identified. These are all unburned elements from small animals and may well be intrusive. Two elements are identified as cotton rat, and one vertebra is from a medium-sized lizard, probably a Texas spiny lizard (*Sceloporus olivaceus*). Only five fragments out of the total have evidnece of burning, and these are small fragments of large animal bones, probably deer.

Feature 5 (Area A) Living floor. Clear Fork.

Although lithic remains suggest a intensively utilized or specialized activity area, this feature yielded only four bone fragments. All four are burned, and all but one are identifiable as deer and turtle.

Feature 6 (Area B) Basin-shaped hearth. Clear Fork.

Eighty-five bone fragments of deer size were recovered, but no specific identification is possible due to the poor state of preservation. Two fragments are burned.

Feature 7 (Area B) Basin-shaped hearth. Clear Fork.

Located below F-6, this smaller hearth yielded only three bone splinters, all unburned and none identifiable.

Feature 8 (Area A) Basin-shaped hearth. San Geronimo.

No bone was recovered.

Feature 9 (Area D) Living floor. Clear Fork.

Feature 9 is the largest occurrence of osteological materials recovered during San Gabriel excavations. As noted in the discussion of Clear Fork material, the feature bone not only mirrors the species composition of the faunal remains found outside the feature, but magnifies it in quantity (Table 15.7-39). Over 5,000 fragments of bone were removed from slightly less than 1 cubic meter of feature matrix. Almost 700 elements from 23 animal taxa are identified. Rodents, rabbits, and small reptiles and fish are moderately represented. Duck and prairie chicken comprise the avifauna. The feature is dominated, however, by butchered deer remains. At least five deer are estimated for the feature. The elements are scattered throughout the 8 sq. meter bone bed, but definite concentrations occur around fire hearths.

A late summer or early winter occupation is indicated by the remains of immature deer. At least three fawns are recorded from the feature based on the left proximal femoral epiphyses. They were each recovered from different units in association with three spatially separated burned rock clusters and may, therefore, represent three different seasonal encampments at the same general location. On the other hand, it is equally possible that the burned rock clusters are either refuse dumpings from the main hearth or individual household cooking areas. Neither of these possibilities can be substantiated from this rather small feature which is known to extend farther west of the excavated position. (See Fig. 15.7-6).

If these deer (adults and fawns) were utilized during a single season's encampment, they would have provided (280 lbs) 127 kg of usable meat for that period. Calculations are based on 60% average field dressed weight of Texas white-tailed deer as recorded by Texas Parks and Wildlife (personal communication). Using Gilbert's (1969) estimate of human daily meat requirement of 2 lbs. (.91 kg), fresh deer meat from this feature could have sustained a group of five adults for about one month. This nutritional estimate is offered in only the broadest sense because many variables affecting reliability of this sort of projection are unquantified. For example, the feature was not completely excavated, and MNI, therefore, may be higher; the contribution of other animal meat is not figured; and furthermore, the occupant's reliance on and utilization of plant foods is unknown. A thorough discussion of estimating meat quantities from faunal remains is treated by Wing and Brown, (1979).

Feature 10 (Area A) Burned rock cluster. San Marcos(?).

Roughly one-third of 28 recovered fragments are burned. Four elements of the total are identified as rodents (pocket gopher and cotton rat), and one is a turtle shell fragment. The turtle carapace fragment is burned. There are, however, eight burned, unidentifiable fragments which are splinters from large mammal bones.

Feature 11 (Area B) Limestone-lined hearth. San Marcos.

Despite recovery of a netate and several projectile points, feature disturbance (probably flooding) has removed faunal evidence. No bone was recovered.

Feature 12 (Area D) Hearth. San Geronimo.

No bone was recovered.

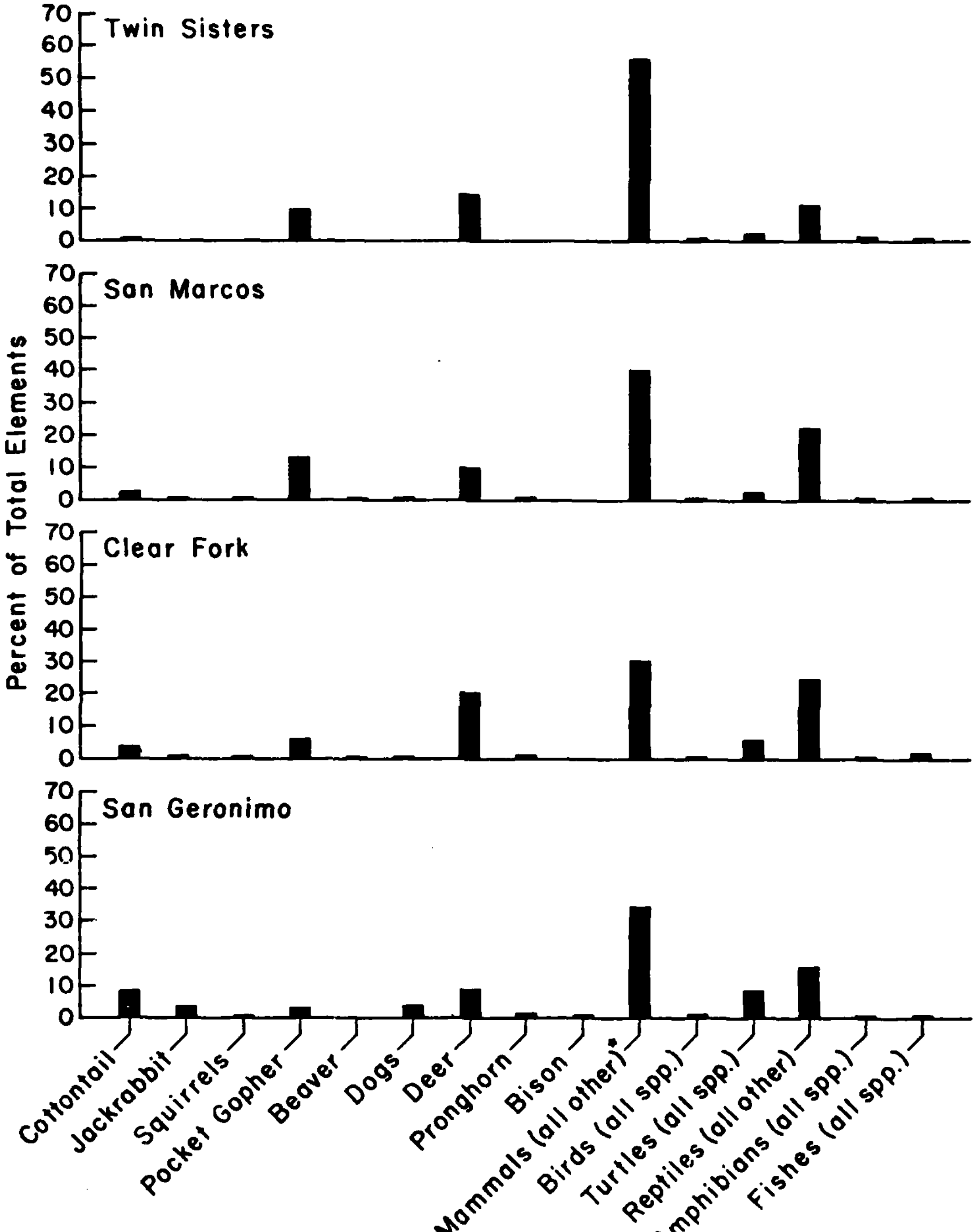
Feature 13 (Area D) Basin-shaped hearth. San Geronimo.

A total of 79 pieces of bone was recorded from this Early Archaic feature. Sixteen of the total are burned, and six of the total are identified (all rodent elements). The unidentifiable sample from the feature contains some deer-sized splinters, but their poor condition precludes positive identification although their presence indicates large mammal utilization as well.

Four other small features all from deep levels at Area D (San Geronimo associated) yielded 54 fragments of which 26% are identifiable. All vertebrate classes except birds and fish are represented among the 14 identified elements. These taxa include pocket mouse, cotton rat, cottontail rabbit, deer, bison, snake, and frog. One of the bison elements is a neural spine from one of the thoracic vertebra. It measures 19.5 cm from base of the facet of the zygopophysis to the end. It is recorded from Feature 26. A loose vertebral epiphysis is recorded from Feature 28 which was located in the adjacent square west of Feature 26. These bison elements are probably related to the individual previously discussed. Deer is represented by a single femur fragment although many undiagnostic fragments are probably from deer as well.

Summary

Despite the great temporal span of occupation at Cervenka, the faunal record suggests very few changes in animal exploitation. Figure 15.7-7 shows relative frequencies of total elements identified for selected species as representatives of woodland habitat or forest (cottontail rabbit, squirrels, deer), grassland habitat or prairie (jackrabbit, pronghorn, bison), and wetland habitat (beaver). Dogs are selected because of possible domestication, and pocket gopher was singled out because it is the rodent most commonly recorded from the excavations. Variation in species size was another factor in selecting these animals.



*mostly rodents

Figure 15.7-7. Selected Species Frequencies, 41WM267.

Overall, the bar graph indicates relative homogeneity through time. However, certain differences are apparent. For example, cottontail rabbit remains decline from the older San Geronimo levels until barely represented during Twin Sisters occupation. Deer is in greatest frequency during Clear Fork, but this may result from the bone bed Feature 9 at Area D skewing the frequency. Turtles and fish are more frequent in the Early Archaic components. Bison is found exclusively in the early San Geronimo levels. Based on the small areas excavated, the sample size is inadequate for determining finer subsistence changes with reliability. Other figures (15.7-8 through 14) are provided for comparative purposes.

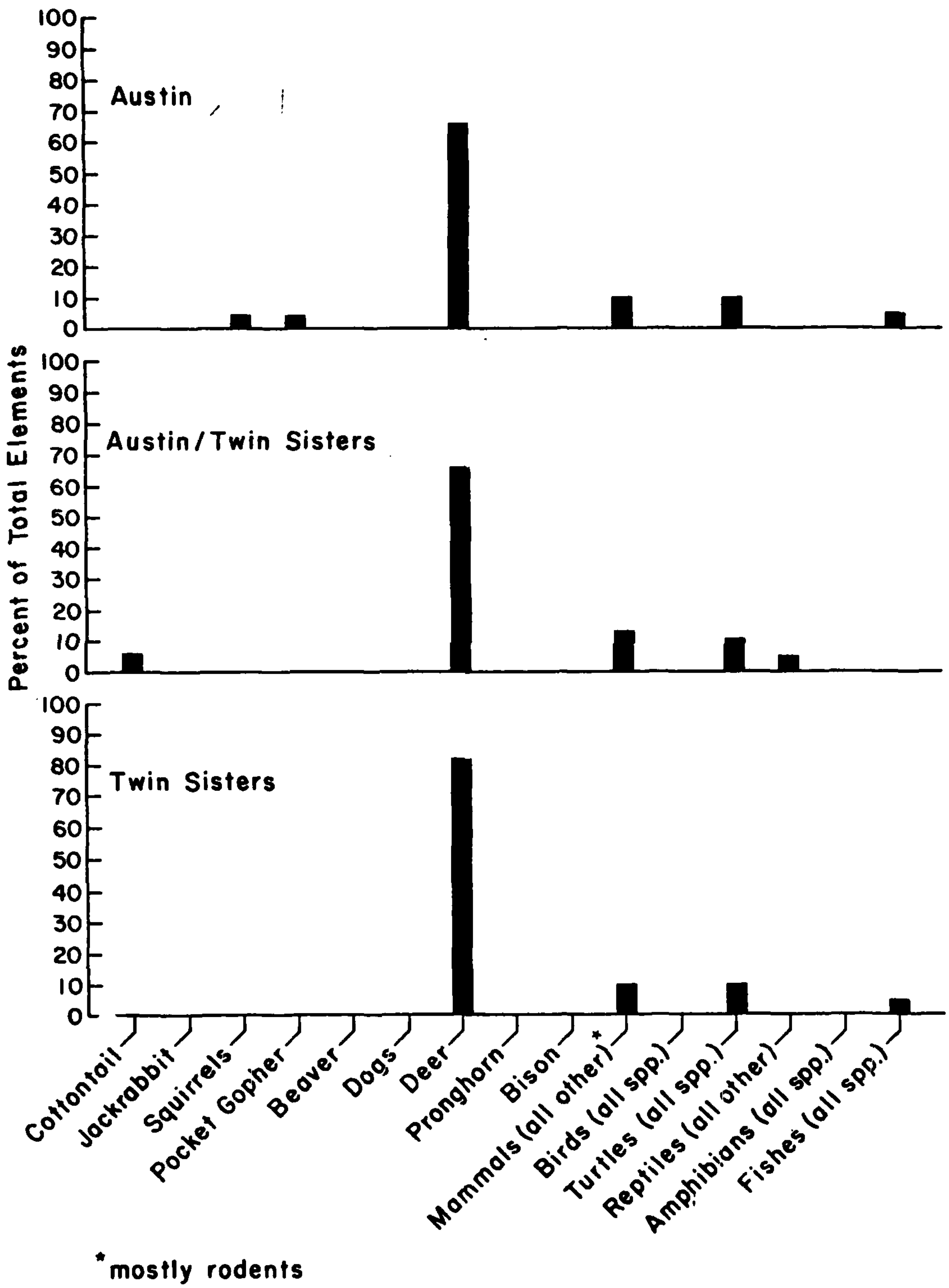


Figure 15.7-8. Selected Species Frequencies, 41WM53.

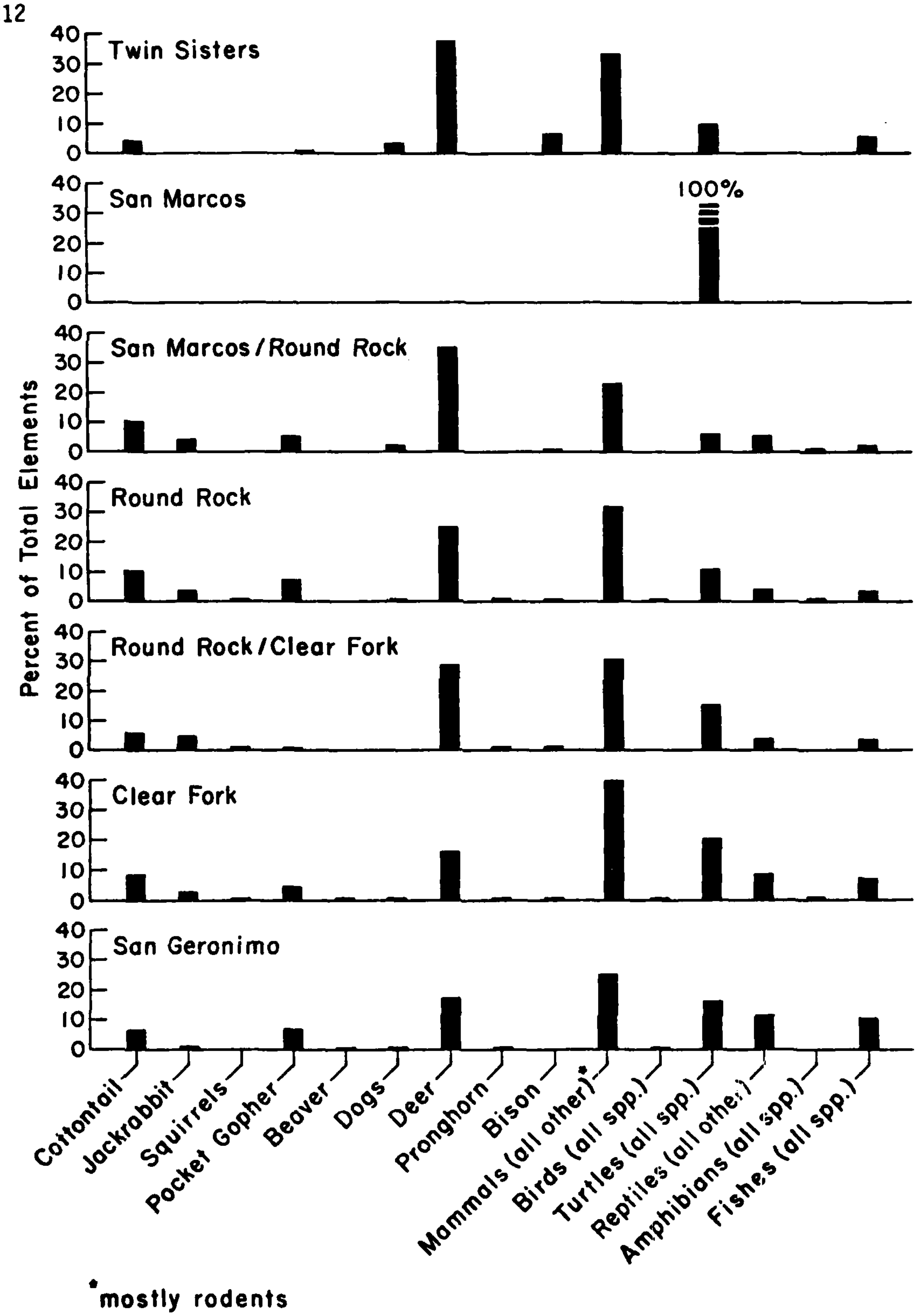


Figure 15.7-9. Selected Species Frequencies, 41WM56.

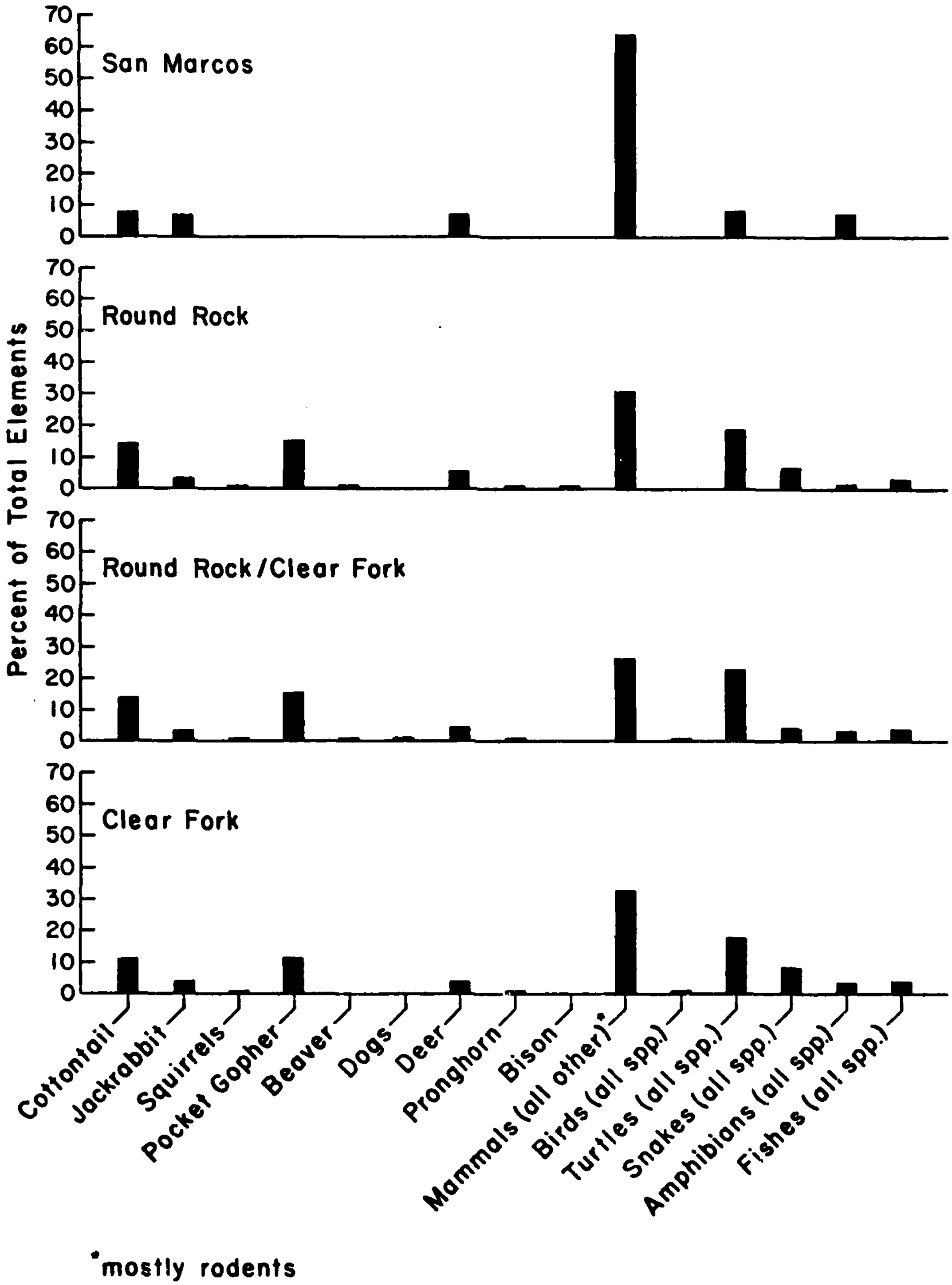


Figure 15.7-10. Selected Species Frequencies, 41WM73.

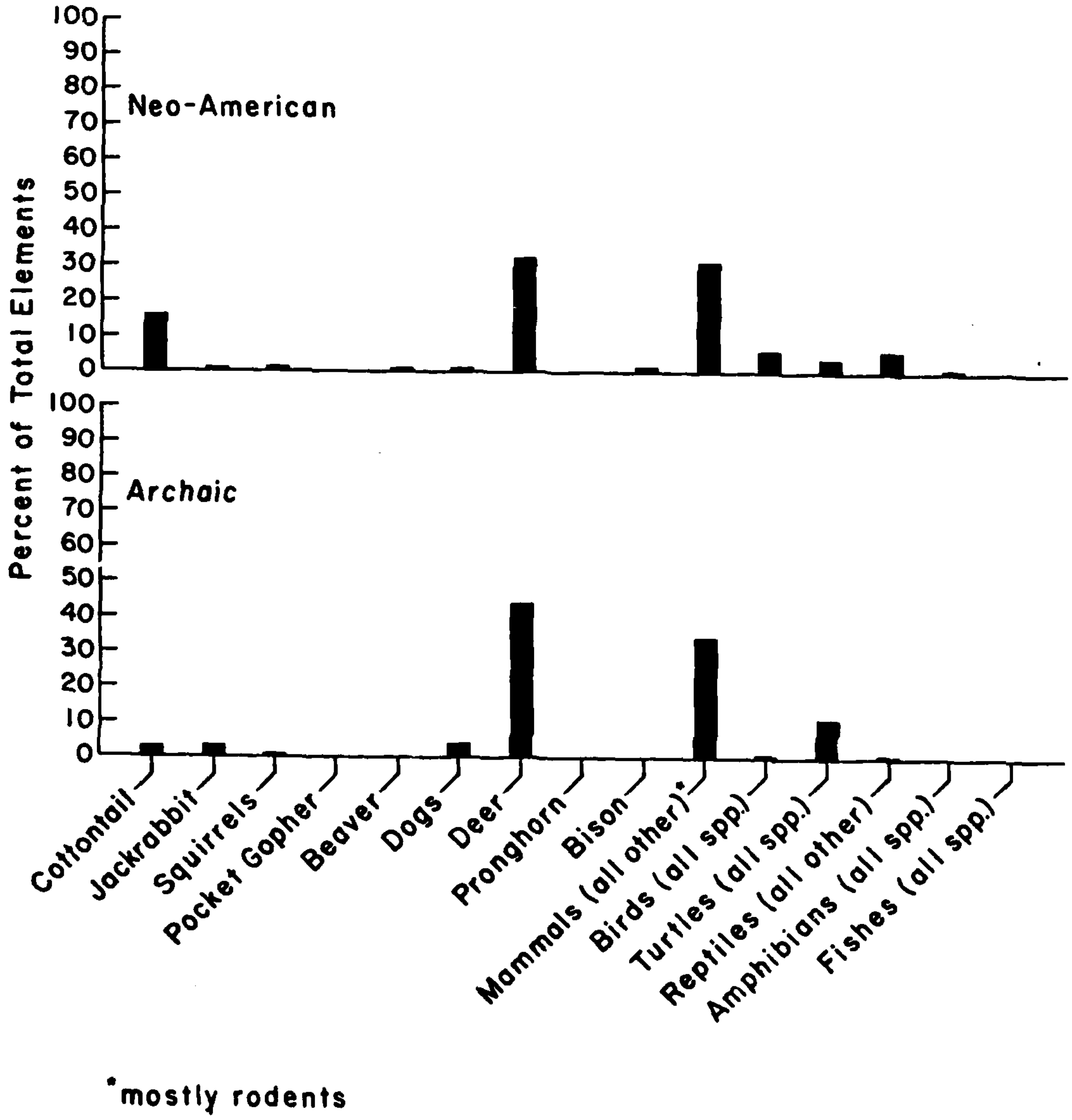
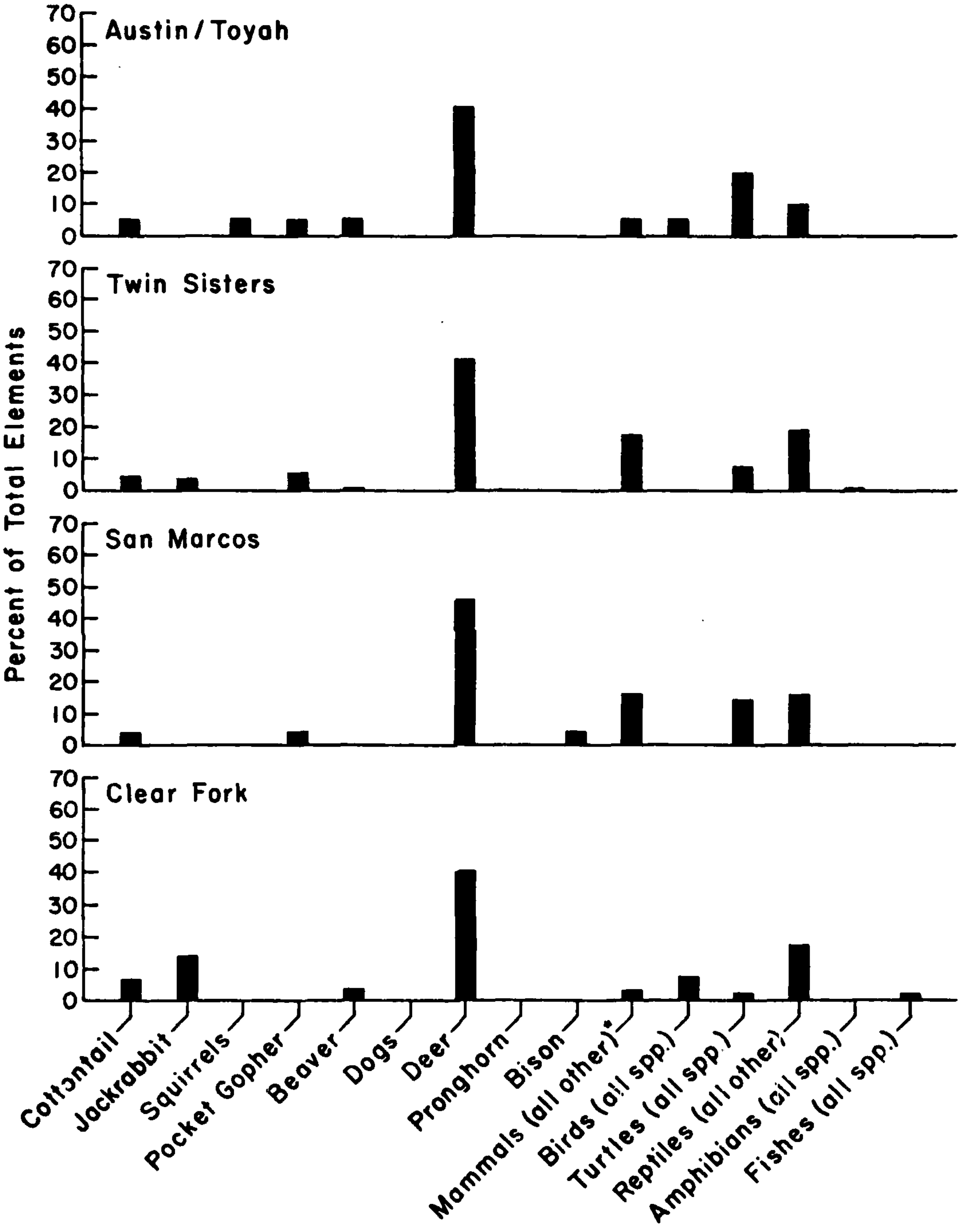


Figure 15.7-11. Selected Species Frequencies, 41WM404.



*mostly rodents

Figure 15.7-12. Selected Species Frequencies, 41WM124.

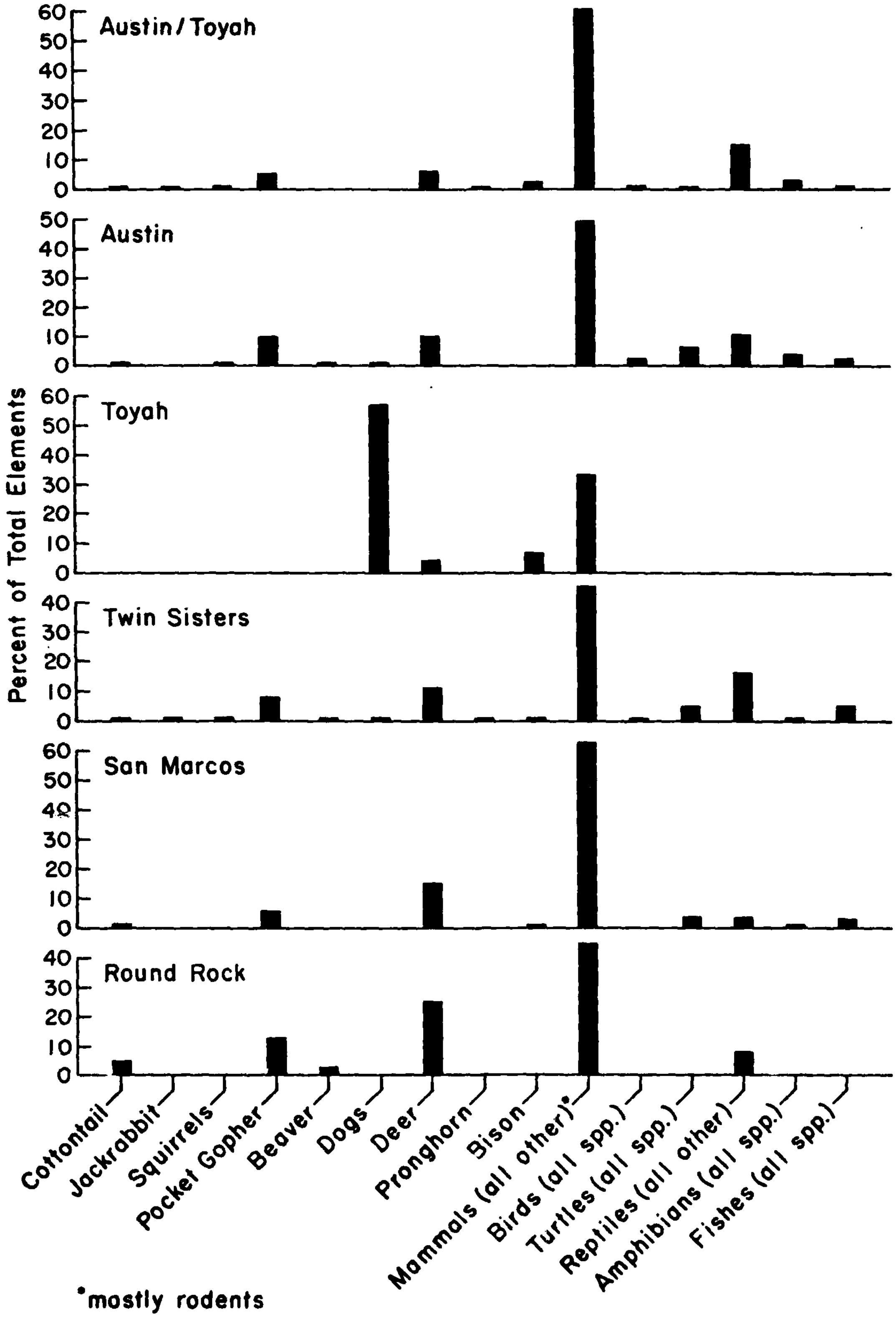


Figure 15.7-13. Selected Species Frequencies, 41WM230.

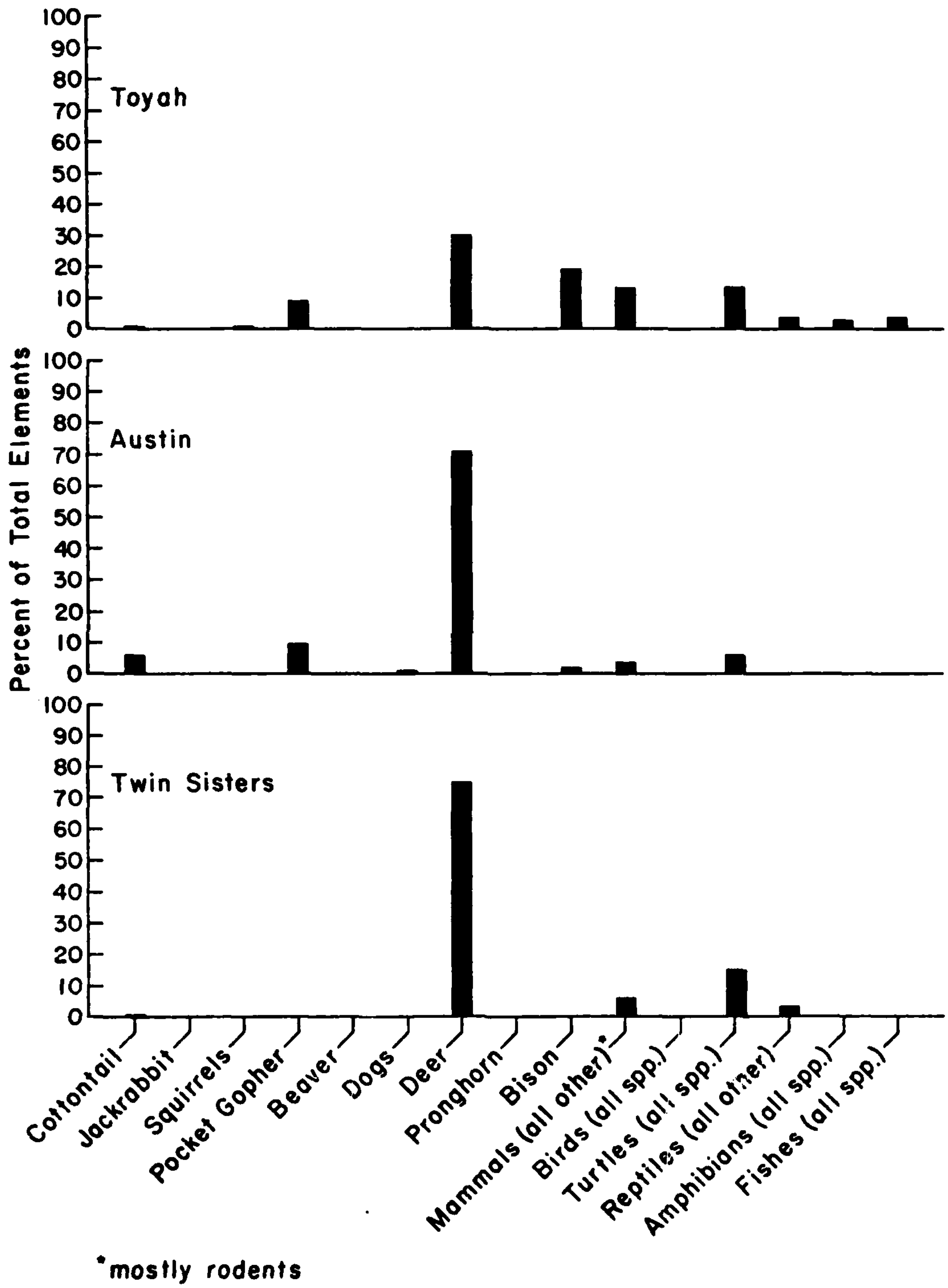


Figure 15.7-14. Selected Species Frequencies, 41WM258.

Limited Testing Sites (Prehistoric)

Six prehistoric sites yielded bones during limited testing activities - 41WM61, 41WM71, and 41WM419 at the North Fork Reservoir and 41WM125, 41WM126, and 41WM368 at the Granger Reservoir. No fine screening was attempted; therefore, only fragments large enough to be retained in ¼" screen mesh were recovered and analyzed. Because excavation was minimal, the resulting osteological material can hardly reveal subsistence patterns or much mroe than a record of some of the species utilized as food. Collected faunal remains from each site are summarized in the following pages.

Site 41WM61

A total of seven pieces of bone were submitted for analysis from this site. The only element identifiable is a deer ulna tool from Area A. It is in extremely poor condition, i.e., pitted and fractured. Its condition would be worse except that it has been charred, which seems to retard the weathering process. The heat exposure must have happened after discard because the jagged break on the working end (which probably rendered the tool unusable) is charred the same color. This tool is further described in the bone tool section of this report.

Site 41WM71

Test trenches #2C and #2D each yielded one bone fragment. Both are from deer-sized mammals, and both are unburned. The fragment from trench #2C is approximately 4 cm long and 1.5 cm wide and exhibits a groove and snap break on one end.

Site 41WM419

The surface-collected bone sample from testing at the Crockett Gardens site is small but interesting. The extensively destroyed site has been evaluated as once having Paleo-Indian assocations. Only one element of the eight fragments collected here is identifiable. It is a right maxillary third molar from a large bovid. It is well mineralized and fragmentary consisting of the central portion of the crown with the distal and mesial sides broken away and roots completely absent except for a small remnant of cementum on the lingual side. Based on occlusal attrition, the individual is "aged", i.e., older than "adult" or more than twelve years old (Fuller 1959). The maximum width of the remaining central portion is 2.68 cm, which is well within size range of extinct forms of bison found by Frison at the Casper Site (Frison 1974). It is, however, incautious to attempt speciation based on a single tooth fragment.

Inferences regarding this specimen are further complicated by its surficial recovery from a disturbed site. Mineralization alone cannot attest to great age for the tooth or other mineralized fragments from this site because of the numerous springs existing in the area which would serve to hasten the mineralization process. Therefore, a tantalizing but insufficient faunal record from this potentially important site adds no information to the archaeological record.

Site 41WM125

Only three fragments are identifiable out of 69 recovered from one test pit extending approximately 80 cm in depth. The site is currently under intense cultivation so that the few bone fragments from level 1 are either recent or not *in situ*. Although lithic artifacts were recovered from the upper levels (Lv. 1-2), bone debris is scant. Below that, bone appears clustered near burned rocks in the northwest corner of the pit in what may be a hearth extending almost 15 cm in depth. In level 6 (just below the "hearth"), cultural debris declines in quantity and kind, and bone density drops from 22 fragments per .1 m^3 to 4 fragments per .1 m^3.

The majority of the faunal remains were removed fr... levels 3, 4, and 5 in which one-third of these are burned brown or black. Few of the burned bones exhibit a white color indicative of intense heat.

The overall condition of the bones is poor. They are badly eroded, pitted and root etched. This attributes to a low frequency of identified remains (4%). The identified pieces appear to be deer, although in the absence of diagnostic teeth and articular ends, the possibility of their identification as pronghorn is also possible. No butchering marks are visible on the elements which consist of a humerus shaft from level 5 and metatarsal shaft fragments from levels 4 and 6. The piece from level 6 is burned.

Site 41WM126

Six test pits were excavated at this terrace site within the southern flood plain of Granger Reservoir. Two pits (T4 and T1) were placed roughly in the center of a surficial artifact area covering approximately 35-40 square meters. The remaining pits were placed at the north end of this area. Approximately 600 bone fragments were recovered from these test pits, and slightly more than half are burned. Thirteen percent of the total were identifiable to some taxonomic degree, with deer bones as the most frequent species identified. Test pit 5 contained the most osteological debris (244 fragments), the majority of which was recovered between levels 2 and 4 (elev. 99.60 and 99.30). Preservation varied between pits but was generally fair.

Based on projectile point identifications, two cultural components are designated. From the surface to elevation 99.30 in test pits 1, 3, 5, and 6, diagnostic points suggest Twin Sisters occupation. Test pit 4 was excavated to elevation 99.40 and would lie within this component, but unfortunately, little cultural debris was recovered.

Below the 99.30 elevation mark, the diagnostic points suggest a San Marcos component. The lower levels of pits 1, 3, 5, and 6 contain associated artifacts, and pit 2, near the terrace edge, lies entirely within this component.

When the contents of the pits are separated by component, the Twin Sisters levels yield more than twice the number of bone fragments than the San Marcos levels. Since the older component is subjected to longer disintegration, the total number of bone fragments and identifiability for it are reduced. Therefore, an estimate of the intensity of occupation based on these test pits is conjectural.

Comparison of species utilization between the two components suggests that procurement patterns differed little. Both components are characterized by an abundance of deer remains. The deer elements are exclusively limited to crania and lower limb, i.e., teeth, antler, distal tibiae, metapodial, carpals, tarsals and phalanges. Burned elements are divided into two categories: (1) the ends of bones where dismemberment takes place and (2) the broken ends of fragments which are charred after breaking. The exclusivity of the elements suggests a butchering site, but the nature of the burned elements points to more domestic activities such as cooking or refuse disposal. A larger sample is needed to clarify the site activity question.

Other large mammals are minimally represented in this small sample. Dental evidence for pronghorn is found in pit 3, and more massive teeth fragment suggesting bison are recorded from pit 5. No non-dental elements for these species are noted. The pronghorn molar is associated with San Marcos levels, and the bison teeth fragments in pit 5 come from the Twin Sisters levels. An incisor fragment in pit 5 is tentatively identified as pronghorn and also comes from the Twin Sisters component. Large mammals probably provided an important dietary source for both cultures.

Medium-sized mammals include jackrabbit on the small end of the "medium" category and wolf on the large end. Jackrabbit is associated only with the San Marcos levels of test pit 2. A wolf-sized calcaneum (unburned) from the Twin Sisters component is the only identified bone from pit 4. Canid teeth are noted from pits 1 and 5. None appear to be larger than domestic dog or coyote. The crowns are burned off, leaving only charred cingulid enamel and roots. Weir (1976) mentions remains of a dog "buried" in a burned rock midden in Travis County and other reported burials from Williamson County sites, but the isolated burned teeth from 41WM126 do not support intentional burial.

Smaller animals include two species of mammal, one bird species and at least two turtle species. Both small mammals come from test pit 5 and are both associated with the lower San Marcos component. One element is the only evidence of cottontail rabbit in the site sample, and its presence as food debris is questionable because it is associated with pocket gopher remains. The rabbit tibia is unburned and rodent gnawed. The pocket gopher elements appear to be from a single immature individual. It is possible that the presence of both species is unassociated with human activities, although both are known food items at other sites.

The only bird species represented is prairie chicken, and it is recorded from the Twin Sisters component of pit 5. It is unburned.

All turtle shell fragments are burned except one from pit 2, and all pits contain trutle remains except pits 4 and 6 (Table 8.5-41). A plastron fragment from a member of the Kinosternidae (cf. yellow mud turtle) is recorded from pit 1. Turtle remains occur in both cultural components.

The following lists summarize the species identified from the test pits at site 41WM126. They are divided by their cultural component associations.

TWIN SISTERS	SAN MARCOS
cf. wolf	cottontail rabbit
deer	jackrabbit
bison	pocket gopher
cf. pronghorn	deer
prairie chicken	pronghorn
turtle sp.	turtle sp.
mud turtle sp.	

Site 41WM368

Only 28 fragments of bone were recovered from two tests pits opened at this site. Three show evidence of burning but are unidentifiable. The only identifiable elements are two deer teeth enamel fragments.

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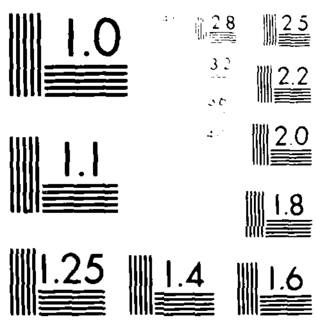

MICROCOPY RESOLUTION TEST CHART

Inter-Reservoir Comparison

The sites under investigation have been divided by reservoir. The North Fork sites occur on the eastern edge of the Edwards Plateau in what Blair (1950) calls the Balconian biotic province. The Granger sites lie in Blair's Texan province. Both provinces meet in Williamson County, and therefore, turn the county into a local ecotone. Blair comments extensively on the ecotonal character of the Texan and Balconian provinces in relation to the more mesic nature of the Austrotirarian forests to the east and the Sonoran deserts farther west. Because of interdigitation of riparian woods and upland prairies in Central Texas, there is a great deal of intermixing of terrestrial vertebrates. If local conditions are right, certain animals will be found far from their regional environment. Furthermore, many animals can tolerate a wide range of edaphic and physiographic factors. Therefore considering the overlapping and intermixture of habitats in this "broad ecotone" (Blair 1950:100), the faunal assemblages are expectedly similar for the sites of either reservoir.

Ideally, a comparison of archaeological sites occurring in two reservoirs of different biotic provinces should produce cultural subsistence distinctions either on a temporal or areal basis. No clear distinctions are apparent from the faunal samples analyzed in this study. Perhaps the distinctions are too discrete to be discerned from zooarchaeological samples which are (1) rarely identifiable to the species or sub-species level at which most habitat differences occur, (2) collected and disposed of originally by mobile humans, (3) redeposited or disturbed by various taphonomic agents, and (4) in this case, excavated from 1% of each site or sub-divided into even smaller samples to be of statistical efficacy.

Nevertheless, some differences between reservoirs are apparent in these samples. For example, freshwater drum is the only species that is represented in a North Fork open site but does not occur in any Granger site. Most likely this fish also occupied muddy or sandy bottoms of waterways in the Granger area as well, but archaeological evidence is lacking.

The North Fork rock shelter (41WM404) contained the only evidence of prairie dog from any of the sites investigated. This occurrence indicates a prairie with thicker topsoil because fossorial species such as prairie dog, pocket gopher, and short-tailed shrew require a reasonable soil thickness for burrowing (Lundelius 1967). Furthermore, of those species, only pocket gophers currently range in the County and then only in localities with a loose, thick soil. The nearest occurrence of prairie dog today is west and south in Mason and Bexar Counties; and the shrew species is now restricted to far east Texas.

The Granger sites produce several taxa that are not recorded from open sites at North Fork. For example, opossum is recorded only from the rock shelter at North Fork (41WM404) but occurs with some regularity at Granger sites. The North Fork area is well within modern opossum range and habitat preference, but its remains are totally absent from the North Fork samples (except 41WM404), even from sites having close riparian proximity in the past. Other mammals found only in Granger samples include harvest mouse (Reithrodontomys sp.), northern grasshopper mouse (Onychomys leucogaster) and either prairie or pine vole (Microtus sp.). The grasshopper mouse is currently found in grasslands or brushlands of far south and west Texas, as well as the Panhandle but not in Williamson County. Archaeologically, it is found as early as San Geronimo and Clear Fork times at Cervenka (41WM267) and as recent as Austin/Toyah and Twin Sisters periods at Loeve Fox (41WM230) with an hiatus in between. The exact species of Microtus is not precisely known from existing remains, but is most likely the pine vole, Microtus or Pitymys pinetorum, which today exists in patchy areas of northeastern and Central Texas. Although prairie voles (M. ochrogaster) no longer occur in Central Texas, Witter (1973) has tentatively identified this species from 41WM125 (cultural affiliation unknown). At Granger, vole remains are recorded from every site except 41WM258 and every cultural component except Round Rock.

Avifaunal remains are much more abundant from Granger than North Fork, and waterfowl are found exclusively at Granger. A plausible explanation for the Granger waterfowl is the meandering nature of the river there causing backwater ponding suitable for migrating ducks. Local reports mention periodic pooling in upland depressions during excessively wet seasons which would also attract waterfowl. Sparrows and cardinals are the only passeriformes (perching birds) identified from any of the sites, and they also are recorded exclusively from Granger sites. Hognose snakes and a salamander species are herptiles found strictly in Granger assemblages. Although this snake species and the birds currently range throughout Williamson County today, it is possible that local conditions were unsuitable at North Fork in the past, especially for certain vole and salamander species that are particularly habitat sensitive.

An examination of represented habitat types was conducted for the sites in each reservoir. In order to determine an exploitation preference of the peoples of a particular cultural period, six potentially exploitable species from each habitat type were chosen for comparison of occurrence. The species chosen to represent the aquatic habitat include beaver, ducks, water turtles, frogs and toads, salamanders, and fishes. Grassland representatives include jackrabbit, pocket gopher, badger, pronghorn, bison and prairie chicken. Woodland creatures used in this study consist of rabbit, fox squirrel, woodrat, raccoon, deer and turkey. Although some of these species' habitat preferences overlap and other species could have been used, the rationale for selecting these animals was to choose species from all vertebrate classes, large ones as well as small, herbivores and carnivores. Based on presence/absence data,

Table 15.7-41 shows thatfor most cultural periods in either reservoir area all habitat types were exploited fairly equally. Woodland creatures were probably the most commonly used and most locally available. The Clear Fork period in both reservoirs is unusual because of the seemingly greater use of aquatic resources. The low representation of Late Archaic periods at North Fork and of the Clear Fork components at Granger is due to insufficent samples and does not necessarily indicate differences between the reservoir areas unless it reflects less frequent or less intensive occupations for reasons thatare imperfectly understood from existing data. Although this approach does not consider intensity of species utilization nor distinguish between natural availability and human selection, it does provide a gross evaluation of habitat exploitation.

Another useful inter-reservoir comparison deals with the utilization and availaibility of bison. Table 15.7-42 shows the sites and components from each reservoir that have yielded bison bones. At Granger, small quantities of bison remains are concentrated in the Late Archaic and protohistoric components. Dibble (1968: 73) has been cited by Dillehay (1975) and others as asserting that the presence of small numbers of bison elements in Central Texas sites suggests that the animal constituted a minor role in subsistence of these people. It may be that bison herds in this region were remnants from larger herds displaced by fluctuating climates, never large in population, and unreliable as a dominant food resource. Berlandier's sitings in 1601 of bison herds, which he claimed did not migrate, slightly postdates Dillehay's Final Presence Period III 1200-1300 to 1550 A.D.). However, the lack of evidence for the presence of bison during the preceding Absence period (i.e., the Twin Sisters period, Table 15.7-42) be attributable to insufficient site data rather than fluctuating range movements. Therefore, it is suggested that the low incidence of bison in these later Granger sites may represent occasional and fortuitous exploitation of small, non-migratory, coastal prairie bison herds.

The corresponding time period at the North Fork sites yielded even fewer bison bones although bison remains consistently appear in the Middle and Late Archaic components of the Hawes Site (41WM56). Again these occurrences of bison may be because of occasional exploitation of small remnant herds, but since the North Fork sites are found on the periphery of the Edwards Plateau and not the Gulf Coastal Plain, their movements (and corresponding availability) may have been controlled more by climatic changes further north that resulted in increased population density and southward expansion (Gunnerson 1972, Dillehay 1975).

Unfortunately without a complete sequence of radiocarbon dates and palynological data, just how the presence and absence record of San Gabriel bison fits into Dillehay's sequences and climatological hypotheses remains unclear. At North Fork, for example, three different sites contain bison in Round Rock components, thus corresponding to Dillehay's Presence Period II (2500 B.D. to A.D. 500). However, the presence of bison at Hawes during Clear Fork occupation may disagree with Dillehay's scheme, but no radiocarbon

Table 15.7-41. Habitat Exploitation based on Presence/Absence of Representative Species.

COMPONENTS

	*	Austin/ Toyah	Twin Sisters	San Marcos	Round Rock	Clear Fork	San Geronimo
North Fork	6				G W		
	5						
	4					A G	
	3				A	W	W G
	2		G	W			A
	1		A W	A G			
Granger	6		W	G		A	W
	5	A G W	A G	A W		G	A G
	4					W	
	3						
	2						
	1				A G W		

Key: A = aquatic G = grassland W = woodland

* Number of representative species present for each habitat type.

Table 15.7-42. Sites Containing Identified Bison Remains

	COMPONENTS						
	Austin Toyah	Twin Sisters	San Marcos	Round Rock	Clear Fork	San Geronimo	Circle-ville
North Fork	41WM404 (cow?)	41WM56	41WM56	41WM56*	41WM56		41WM419
			41WM57	41WM57			
				41WM73			
Granger	41WM230	41WM230	41WM230			41WM267**	
	41WM258	41WM126	41WM124				
			41WM163				

* 3225±75 BP (UGa 2480), corresponding corrected date = c.1583 BC.

** 4970±90 BP (Tx 3684), corresponding corrected date = c.3788 BC.

dates are available from the stratum containing these bones, and yet, conventional dates for Clear Fork correspond to Dillehay's Evidence of bison and accompanying radiocarbon date from the lowest levels excavated at Cervenka (41WM267) contrast with Dillehay's Absence Period I (6000-5000 to 2500 B.C.). In both cases, however, incidental exploitation of remnant herds must be considered.

Finally, despite all of the "if's" and "however's," the faunal record of the San Gabriel River Valley sites, as sampled, suggests that (1) exploitation patterns differed very little either temporally (between components) or spatially (between reservoirs), and (2) climatic changes were insufficient to dramatically alter subsistence strategies. It must be stressed that complete radiocarbon dates, more palynological and sedimentological data, and large scale faunal sampling are required before clearly establishing conclusions concerning change in human/animal relations in Central Texas.

VII. SYNTHESIS:

THE ARCHAEOLOGY OF THE SAN GABRIEL RESERVOIR DISTRICTS

by

Duane E. Peter, T. R. Hays, and Marie-Anne Demuynck

The purpose of archaeological research is to provide an understanding of man's way of life in the past. Specifically, this project was oriented to examine prehistoric adaptations through time in the San Gabriel River Valley. The goal was to develop the cultural history of each of the reservoir districts using as varied a data base as possible. This process involved the integration of the study of cultural materials with environmentally sensitive indicators such as floral and faunal analyses. Although these latter analyses have been considered as "ancillary studies" by some other researchers, it is the premise of this study that a meaningful cultural-historical perspective must include relevant ecological data. Consequently, the following chapters will provide a synthesis of the data from each reservoir aimed at delineating the cultural history and ecology of each area. The presentation focuses on the adaptations by each cultural/time stratigraphic unit, followed by a summary statement. These descriptions discuss the interpreted chronology, artifact assemblages, and settlement/subsistence patterns of each cultural period.

16.0 The Archaeology of North Fork Reservoir

16.1 Circleville Phase

Recognition of this phase in the North Fork Reservoir relies totally on the occurrence of diagnostic elements such as Angostura, Meserve, and Golondrina projectile point types. Unfortunately, these projectile points were recovered only from site 41WM419 which was almost completely removed by borrow pit activities. Consequently, only limited observations concerning the adaptive strategy of this phase can be offered.

The Angostura, Meserve, and Golondrina points are presently recognized as the index markers of the Circleville Phase (Prewitt 1981, Patterson 1977). These projectile point types are often found in stratigraphic association in Central Texas (Alexander 1963; Hester 1978) as well as Southwest Texas (Johnson 1964; Dibble and Lorrain 1968). The majority of the radiocarbon dates for these projectile forms, however, are from Southwest Texas. All of these dates cluster between 7,000 and 8,000 B.P. (Word and Douglas 1973:34, Hester 1978:4; Dibble and Lorrain 1967; Sorrow 1968). More appropriate to the occupations of the San Gabriel River Valley are the radiocarbon dates from the Loeve Site (41WM133) in the Granger Reservoir. These four dates, 6900 ± 100 B.P. (Tx-805), 7000 ± 160 B.P. (Tx-802, 803), 8500 ± 130 B.P. (Tx-2675), and 9650 ± 910 B.P. (Tx-3405), place this occupation of the San Gabriel River Valley in the time frame of 7000 to 8500 B.P. Only Angostura-like points are associated with the 8500 B.P. date. As a result, the time frame for this phase within the San Gabriel River valley remains largely conjectural.

In addition to the projectile points, the North Fork assemblage is also characterized by Clear Fork gouges. These tools appear only in this component in the North Fork Reservoir. Other than these diagnostic elements, retouched pieces are the dominant tool class for they comprise 37.9 per cent of the tools from the excavated units. Bifaces, probably underrepresented in this small sample, comprise only 17.3 per cent of the sample. Burins or burin spalls (13.8%), scrapers (13.8%), notches (6.9%), points (6.9%), and gouges (3.5%) comprise the remainder of the tool sample. Unlike many of the later components, cores and core fragments (18) are well represented. The distinctive discoidal cores recovered from the borrow pit are not found in any of the later components from the borrow pit, but their association with the Circleville component cannot be established with absolute certainty.

Features of this phase consist of informal clusters of burned rock. From the limited data base, it appears that discrete activity areas were focused around these hearths. The few faunal remains associated with the features denote the utilization of molluscan fauna and small

mammals. Larger segments of bone recovered from the borrow pit indicate that deer and bison also were primary food sources during this phase. A generalized foraging economy, not unlike that of the following San Geronimo Phase, may be postulated for this phase in the North Fork Reservoir. From the dense accumulation of cultural debris in the center of the borrow pit, it is apparent that this locale was visited repeatedly during the Circleville Phase. The probable presence of springs along the valley margin would have made this locale especially appealing during this period.

16.2 San Geronimo Phase

The San Geronimo Phase is best represented in the North Fork Reservoir by the earliest component of the Hawes Site (41WM56). Diagnostic elements of this phase are also present at the base of sites 41WM57 and 41WM304. Unfortunately, no radiocarbon dates are available from these components. The stratigraphic position of Martindale, Hoxie, Wells, Uvalde, and previously undefined projectile points (Groups 10, 12, and 13) are the index markers of this phase. The isolated presence of "Tortugas" type specimens beneath the midden at site 41WM304 may indicate a San Geronimo component, although the temporal specificity of the "Tortugas" specimens only to the San Geronimo Phase is questionable. The San Geronimo component of site 41WM57 was minimally sampled by the Area D excavations. A single projectile point (Group 12) in the deepest level of Area D provided the basis for this component designation. A stylistically similar specimen was also the earliest specimen recovered from the Cervenka Site (41WM267) in the Granger Reservoir. The stratigraphic relationship of the above mentioned index markers to radiocarbon dates from the Cervenka Site indicates that the temporal span of 5,000 to 6,000 B.P. is a reasonable estimate for this occupational phase within the North Fork drainage.

A total of 159 tools from site 41WM56 and 38 from site 41WM57, excluding projectile points, were collected from the San Geronimo components. Several tool classes present in the site 41WM56 collection were absent in the site 41WM57 collection. This difference may be due to the much smaller sample at the latter site (Table 16.2-1).

Biface fragments (52.28%) and retouched pieces (22.34%) make up the major part (74.62%) of the San Geronimo tool kit in the North Fork Reservoir. Excluding those, a "restricted percentage" results of which 20% of the remaining tools are complete bifaces and preforms of the miscellaneous subtype. Notched pieces, mostly single notches, are important (restricted % = 18), although they are present only at 41WM56. Burins also are important (restricted % = 16), as are denticulates (restricted % = 14). The burins are almost exclusively angle and dihedral burins. Denticulates are mainly simple denticulated flakes, although two serrated pieces were found at site 41WM57. Backed pieces (restricted % = 10), mostly single convex backed flakes, are present at site 41WM56 only. Scrapers are unusually scarce (restricted % = 8), especially at site

TABLE 16.2-1: Totals, percentage and restricted percentage for the tools from the San Geronimo Phase in the North Fork Reservoir.

	Site 41WM124			Site 41WM267			Granger Res.		
TOOL CLASSES	#	%	Restr.%	#	%	Restr.%	#	%	Restr.%
Scrapers	1	.63	2.63	38	7.89	25.00	4	2.03	8.00
Denticulates	4	2.52	10.53	3	7.89	25.00	7	3.55	14.00
Notched p.	9	5.66	23.60				9	4.57	18.00
Gravers	3	1.89	7.89				3	1.52	6.00
Picks	1	.63	2.63				1	.51	2.00
Truncations	3	1.89	7.89				3	1.52	6.00
Backed p.	5	3.14	13.16				5	2.54	10.00
Burins	7	4.40	18.42	1	2.63	8.33	8	4.06	16.00
Retouched p.	36	22.64	-	8	21.05	-	44	22.34	-
Bifaces	5	3.14	13.16	5	13.16	41.67	10	5.08	20.00
Biface frags.	85	53.46	-	18	47.38	-	103	52.28	-
TOTAL	159	100.00	100.00	38	100.00	100.00	197	100.00	100.00
Rest. TOTAL	38			12			50		

41WM56 with only one scraper. Double endscrapers are dominant and no single end- or single sidescrapers were found. Truncations (restricted % = 6) were found at site 41WM56 only; they are mostly distal truncations, although one proximal truncation occurs. Boring tools, also only recovered at site 41WM56, are mostly oblique gravers (restricted % = 6), but one is a pick (restricted % = 2). The other tool classes are absent.

Cores are few in the San Geronimo components of the North Fork Reservoir, for they are found at site 41WM56 only. Single platform cores (57%) predominate this limited sample.

The density of lithic debitage and tools in the San Geronimo components of these three sites is quite low. This relatively low density of cultural material suggests a rather mobile adaptation. Occupancy of a given site was probably ephemeral. The only features uncovered were informal clusters of burned rock which represent the remains of simply prepared hearths. The broad horizontal expanse of the component at the Hawes Site, however, indicates that favorable site locations were utilized periodically.

Site location is consistently well back from the present San Gabriel River channel. For sites 41WM56 and 41WM57 there is no evidence that the river channel would have been closer during the San Geronimo Phase. Both sites 41WM304 and 41WM56 are situated at the base of a steep upland slope. Site 41WM57 is located on alluvial fan deposits from an upland drainage. The gastropod fauna from each of these sites suggests that the site environments were rather open with little overstory vegetation during the San Geronimo Phase. It is doubtful, however, that the climate was significantly drier than today; aquatic resources are well represented.

The exploitation of a diverse group of food resources is reflected in the faunal assemblages. Aquatic and woodland faunae are dominant in the San Geronimo Phase. In fact, the utilization of the aquatic resources ranks below only that of the following Clear Fork Phase. Prairie fauna, such as jackrabbit and pronghorn antelope, are only minimally represented. This diversity of food resources suggests that these sites did not function as specialized hunting camps, but rather as ephemeral foraging camps for a small band of hunter-gatherers.

16.3 Clear Fork Phase

The data base for the Clear Fork Phase occupations in the North Fork Reservoir is perhaps the best of the entire occupational sequence. Sites 41WM56, 41WM57, 41WM73, 41WM304, and the previously excavated John Ischy Site (41WM49) (Sorrow 1969) contain significant Clear Fork components. Although the context of the Clear Fork material is not as good at sites 41WM61 and 41WM404, they were inhabited during this period also. The chronological framework for this phase is provided by radiocarbon dates from sites 41WM56 and 41WM73. Dates of 3615 ± 60 B.P. (UGa-2485) and 3750 ± 90 B.P. (UGa-2473) from site 41WM56 place the Clear Fork occupations

between 4,000 and 5,000 B.P. Although the sigma value of the 5285 ± 785 B.P. (UGa-2482) date from site 41WM73 is large, the associated diagnostic artifacts suggest relative contemporaneity with the occupations at site 41WM56. These diagnostics include Bulverde, Group 14, Nolan, Travis, and other previously undefined projectile point types (Groups 2, 4, 5, 7, and 11).

A total of 437 tools from site 41WM57, 21 from site 41WM73 and 108 from site 41WM304, excluding projectile points, were collected from excavation of the Clear Fork components. Two sites have very small samples and lack several of the tool classes present at the two other sites. The same two sites also have markedly lower tool and debitage densities for this cultural component (Table 16.3-1).

Biface fragments are the largest single artifact class, accounting for 57% of the total Clear Fork tool assemblage. Retouched pieces follow with 22%; they are predominantly unilaterally retouched flakes. At one site they are predominantly bilaterally retouched. Excluding the two above tool classes, 23% (restricted %) of the tools are scrapers, which makes them relatively much more important than in the San Geronimo component. Most of the scrapers are single, side- or endscrapers. "Giant" scrapers also are common and double scrapers are present, but rather rare. Most of the latter come from site 41WM73, a site which differs from the other North Fork sites in this component by its higher percentage of scrapers. Notched pieces and burins occur in equal numbers (restricted % = 19). Most of the notches are single notches on flakes, but there are several other subtypes. The occurrence of several strangulated pieces is interesting. Burins are abundant only at site 41WM56 and display a wide variety of subtypes. Most are single angle burins, although double and dihedral burins are fairly common. Complete bifaces and preforms are rather rare, especially compared to the enormous amount of biface fragments. Most are finished bifaces, medium to large triangular and subtriangular tools with an accentuated working end. Denticulates (restricted % = 10) are exclusively simple denticulated flakes. Truncations (restricted % = 6) occur infrequently, and are as often proximal as distal; several were made by ventral retouch. Even more infrequent are the backed pieces. In contrast to their relative importance during the San Geronimo Phase, they occur now only at site 41WM56. Two drills and one pick (restricted % = 2 and 1, respectively) are all the boring tools that were found. Also encountered were a composite tool, a scaled and battered piece and one unifacial, all from site 41WM56.

Cores came mostly from site 41WM304 (8) and site 41WM56 (12). Both sites have as many double as single platform cores, while multiple platform cores are relatively few. Generally, cores occur much less frequently than in the San Geronimo component.

Intensity of occupation and perhaps the focus of activities at the major sites are changing during this phase. Relatively lower densities

TABLE 16.3-1: Totals, percentages and restricted percentages for the tools from the Clear Fork Phase in the North Fork Reservoir.

	Site 41WM56			Site 41WM57			Site 41WM73			Site 41WM304			North Fork Reservoir		
TOOL CLASSES	#	%	Restr.%	#	%	Restr.%	#	%	Restr.%	#	%	Restr.%	#	%	Restr.%
Scrapers	19	4.35	21.35	2	9.52	28.57	3	9.09	42.86	5	4.63	23.81	29	4.84	23.39
Denticulates	5	1.14	5.62	2	9.52	28.57	2	6.06	28.57	4	3.70	19.06	13	2.17	10.48
Notched p.	14	3.20	15.73	2	9.52	28.57	2	6.06	28.57	5	4.63	23.81	13	3.84	18.55
Drills	1	.23	1.12							1	.93	4.76	2	.33	1.61
Picks	1	.23	1.12										1	.17	.81
Truncations	5	1.14	5.62							2	1.85	9.52	7	1.17	5.65
Backed p.	4	.92	4.49										4	.67	3.23
Burins	20	4.58	22.48	1	4.76	14.29				2	1.85	9.52	23	3.84	18.55
Composite T.	1	.23	1.12										1	.17	.81
Retouched p.	86	19.68	-	9	42.87	-	9	27.27	-	27	25.00	-	131	21.86	-
Bifaces	17	3.89	19.11							2	1.85	9.52	19	3.17	15.30
Biface frags.	262	59.95	-	5	23.81	-	17	51.52	-	60	55.56	-	344	57.42	-
Scaled/batt.	1	.23	1.12										1	.17	.81
Unifacials	1	.23	1.12										1	.17	.81
TOTAL	437	100.00	100.00	21	100.00	100.00	33	100.00	100.00	108	100.00	100.00	599	100.00	100.00
Restr. TOTAL	89			7			7			21			124		

of cultural materials are associated with informal clusters of burned rock (hearths) within the lower levels of the Clear Fork components. Basin-shaped hearths also appear during this period. As utilization of these sites increases during the Clear Fork Phase, massive accumulations of burned rock begin to form. Classic burned rock middens are initiated at sites 41WM57, 41WM61, 41WM73, and 41WM304. Basin-shaped hearths or ovens are consistently present at the base of these massive accumulations of burned rock. At the Hawes Site (41WM56) the classical mound of burned rock was not formed. Nevertheless, massive accumulations of burned rock are present during the latter part of the Clear Fork Phase, and individual hearths are not recognizable within this accumulation.

The function of these sites during the Clear Fork Phase is not entirely clear. Early in the phase, the foraging pattern of the earlier San Geronimo Phase is continued. As time progresses, the diversity of species utilized increases at sites 41WM56 and 41WM73 (Chapter 15.7). Although a sampling problem may exist at site 41WM57, species diversity is significantly lower. Site 41WM73 also exhibits a notable lack of large mammal remains; its occupants apparently were focusing on smaller game.

This variability in faunal resources may be related to the differing functions of these sites. The Hawes Site (41WM56) remains as a generalized foraging camp that was utilized either more frequently or for longer periods of time as a base camp. The increased diversity of faunal resources and lithic tools, especially the increased presence of ground stone tools (Chapter 14.6, Table 14.6-1), and the presence of a probable storage pit suggest that the latter is more likely. At sites 41WM57, 41WM61, 41WM73, and 41WM304 occupation seems to be focused on activities that produce massive accumulations of burned rock. Since the faunal resources are not as intensively exploited as at the Hawes Site, the function of these sites may be oriented to the processing of floral food resources. The macrobotanical remains recovered from flotation (Chapter 15.2) indicate that acorns, pecans, and walnuts were utilized. Grasses also are represented. Of these floral remains, only the necessary parching of acorns for winter storage (Hillard 1980) would have required the use of heated rocks as a griddle or the lining of a pit. Whether or not this was the actual function of these sites, they exhibit a degree of functional specialization not evident at the Hawes Site.

The fauna from the Clear Fork components of these sites indicate that all of the available habitats (aquatic, woodland, and grassland) are being exploited (Chapter 15.7). The minimal representation of the larger grassland species, such as bison and pronghorn, however, indicates that such herd animals were not nearby and did not contribute a major portion of the inhabitant's subsistence while occupying these sites. The high incidence of aquatic species denotes a period of sufficient moisture. The gastropod fauna (Chapter 15.6) do not necessarily confirm this interpretation but, an overly dry environment is not indicated. Certain species

of gastropods (P. mooreana, H.o. tropica) present within the Clear Fork components indicate that moisture levels were sufficient to support overstory vegetation on the terraces.

16.4 Round Rock Phase

The massive accumulations of burned rock which were initiated during the Clear Fork Phase increased in size during the Round Rock Phase. Sites 41WM57, 41WM73, and previously investigated sites 41WM81 (Sullivan, Hays, and Humphreys 1976), 41WM188 (Sorrow 1973), and the John Ischy Site (Sorrow 1969) were the loci of much activity during this phase. A portion of the midden accumulations at sites 41WM61 and 41WM304 probably were deposited during this period, also. As in the Clear Fork Phase, the character of the midden accumulation at the Hawes Site continues to be somewhat unique relative to the other sites. Although the Round Rock occupations are not always stratigraphically discrete at the Hawes Site, occupational intensity during this phase was relatively high. A date of 3225 ± 75 B.P. (UGa-2480) was obtained from charcoal recovered in Level 5, Area C of the Hawes Site. Pedernales and Bulverde point types, the recognized index markers of this phase, are the predominant specimens within this level. Unfortunately, the designation of the Round Rock Phase at the remainder of the sites relied only upon the presence of these index markers. The additional presence of Marshall or Castroville point types in associate with Pedernales points is viewed as an expected late Round Rock Phase association. This association was most clearly evident at site 41WM57.

A total of 143 lithic tools from site 41WM56, 59 from site 41WM57, 145 from site 41WM73 and 46 from site 41WM304, excluding projectile points, were collected during excavation of the Round Rock cultural component in the North Fork Reservoir. Tool and debitage densities during this time period are intermediate, except for site 41WM56 where they are very high.

Biface fragments, comprising more than 40% of the tool kit, are again the most abundantly represented tool class at all sites. The second largest tool class is retouched pieces which comprise 30% of the total tool assemblage. In sites 41WM56 and 41WM73, most retouched pieces were bilaterally flaked (Table 16.4-1).

There are some differences among the sites in the other tool classes. For site 41WM304 this may be due to its relatively small sample, because it lacks several tool classes. Site 41WM57 presents the same problem. The differences between sites 41WM56 and 41WM73 are of another order. Scrapers are more important at the former, while denticulates and notched pieces are more numerous at the latter. Site 41WM56 also has more burins and more complete bifaces and preforms.

TABLE 16.4-1: Totals, percentage and restricted percentage for the tools from the Round Rock Phase in the North Fork Reservoir.

TOOL CLASSES	Site 41WM56 #	%	Restr.%	Site 41WM57 #	%	Restr.%	Site 41WM73 #	%	Restr.%	Site 41WM304 #	%	Restr.%	North Fork Reservoir #	%	Restr.%
Scrapers	17	11.88	34.00	4	6.78	23.54	7	4.83	20.00				28	7.12	25.45
Denticulates	4	2.80	8.00	2	3.39	11.76	6	4.14	17.13				12	3.05	10.91
Notches	5	3.50	10.00	6	10.17	35.30	13	8.97	37.13	5	10.87	62.50	29	7.38	26.35
Gravers							1	.69	2.86				1	.25	.91
Drills	2	1.40	4.00				1	.69	2.86				3	.76	2.73
Truncations	1	.70	2.00				1	.69	2.86				2	.51	1.82
Backed p.	2	1.40	4.00	2	3.39	11.76	1	.69	2.86				5	1.27	4.55
Burins	7	4.90	14.00	1	1.69	5.88	1	.69	2.86	1	2.17	12.50	10	2.54	9.09
Retouched p.	34	23.77	-	21	35.60	-	45	31.03	-	15	32.62	-	115	29.68	-
Bifaces	8	5.59	16.00	2	3.38	11.76	1	.69	2.86	2	4.34	25.00	13	3.31	11.82
Biface frags.	59	41.26	-	21	35.60	-	65	44.82	-	23	50.00	-	168	42.77	-
Axes	2	1.40	4.00				1	.69	2.86				3	.76	2.73
Gouges							1	.69	2.86				1	.25	.91
Chopping T.	1	.70	2.00										1	.25	.91
Scaled/batt.							1	.69	2.86				1	.25	.91
Unifacials	1	.70	2.00										1	.25	.91
TOTAL	143	100.00	100.00	59	100.00	100.00	145	100.00	100.00	46	100.00	100.00	393	100.00	100.00
Restr. TOTAL	50			17			35			8			110		

As a whole, the North Fork Reservoir tool assemblage consists of more or less 70% biface fragments and retouched pieces. Excluding those, notched pieces (restricted % = 26) are the most important tool class, with scrapers a close second (restricted % = 25). There is a large variation among the notched pieces, most of which are single notched flakes, but there are also numerous multiple notched pieces. Meganotches and strangulated pieces also are present. Most scrapers are single sidescrapers, but there is an important contingent of corescrapers. Most other subtypes also occur, but they are few. Interesting is the large number of denticulated single sidescrapers at site 41WM56. Complete bifaces and preforms (restricted % = 7 and 5, respectively) are mostly medium to large triangular to subtriangular bifaces. A few small bifaces occur, as well as one notched biface. Denticulates (restricted % = 11) are almost exclusively simple denticulated flakes. There is only one denticulated blade, and no serrated pieces. Burins (restricted % = 9) are only half as important as during the preceding Clear Fork Phase, and were found mostly at site 41WM56. These tools are predominantly single angle burins on snaps, while all the other subtypes are rare. Backed pieces (restricted % = 6) are backed along one edge only, mostly along an entire edge, sometimes only partially. Boring tools are nearly as few as they were during the Clear Fork Phase. There was one graver; the other boring tools are drills. Truncations are very scare (restricted % = 3). Other tool classes found in the Round Rock component of the North Fork Reservoir are gouges, chopping tools, scaled and battered pieces, and unifacials. Each of these tool classes is represented by one specimen only.

Only 14 cores were found within the Round Rock component levels. Most were found at site 41WM56 while site 41WM57 had none at all. There is no preference for any core type; single and multiple platform cores occur in equal quantities. Other core types are rare.

Late Round Rock Phase occupations (previously designated as Round Rock/San Marcos transition) are present at the Hawes Site (41WM56) and site 41WM57. Site 41WM56 has 67 tools (23 used in cumulative diagram) in this cultural unit, while site 41WM57 has 298 tools (184 used in cumulative diagram). The discrepancy in tool sample sizes is probably the main reason for the differences that show in the cumulative graph (Fig. 8.2-19). All tool types present at site 41WM56 are also present at site 41WM57, but there are considerably more tool types at the latter site. The tool and debitage densities are very high at site 41WM56, less at site 41WM57.

As before, retouched pieces and biface fragments make up more than 70% of the total tool sample, excluding projectile points. Biface fragments are the larger class with 40% of the tools. Most of the retouched pieces are unilaterally retouched flakes at site 41WM57, bilaterally at site 41WM56. Scrapers and notched pieces have the highest frequencies when excluding the two above categories (restricted % = 22 and 24, respectively). Most endscrpaers are single endscrapers,

almost exclusively made on flakes. Double and multiple scrapers are frequent, while single sidescrapers are few. Notched pieces occur in all varieties at site 41WM57 with many made on blades. There are also several pieces with a maganotch. Complete bifaces and preforms (restricted % = 12 and 6, respectively) are numerous, and are mostly medium to large, triangular to subtriangular tools. There is only one miscellaneous form, a shouldered biface. Denticulates (restricted % = 9) are mainly simple denticulated flakes; serrated pieces are few. Truncations were found only at site 41WM57, and are mostly single distal truncations, made by dorsal retouch. Only one tool was truncated proximally. Boring tools are rare, except for drills (restricted % = 8, 6% of which are drills). Other tool types are scarce. Backed pieces, burins and axes occur in equal amounts (2); and there is one composite tool.

The cores are mostly multiple platform cores (14 or 56%). There are six single platform cores (24%) and four wedge cores (10%). One subdiscoidal core was found at site 41WM57. There were no double platform cores in our sample for the late Round Rock components.

Occupational intensity apparently remains at the level attained during the latter half of the Clear Fork Phase. The classic mounds of burned rock at sites 41WM57 and 41WM73 and the more diffuse occupational midden of the Hawes Site continued to grow. The specialized nature of the mounds at sites 41WM57 and 41WM73 is indicated by the differential distribution of artifacts. At both sites the density and diversity of artifacts are greater in areas peripheral to the mounds of fire-cracked rock. The occupational middens within these areas are very similar to the accumulations at the Hawes Site.

Although the massive accumulation of burned rock made the detection of features very difficult, three types were recognized. Basin-shaped hearths and informal burned rock clusters were identified at site 41WM57. A larger pit hearth or oven was recognized at site 41WM73. At both sites the basin-shaped or pit hearths were associated with the mounds of burned rocks. The informal burned rock clusters were located in the more diffuse occupational middens of the Hawes Site and site 41WM57.

The recovery of macrobotanical remains from both the hearths and the accumulation of burned rock indicates that floral resources such as hackberry seeds, acorns, and pecans were utilized. As in the preceding phase, acorns are the dominant floral resource. Remains of *Chenopodium* sp. and *Juniperus* sp. also were present. The macrobotanical remains, therefore, indicate the presence of floral communities which are similar to those of today.

16.5 San Marcos Phase

The intensity and the nature of the prehistoric occupations in the North Fork Reservoir area are relatively unchanging during the San Marcos Phase. Unfortunately, the total lack of radiocarbon dates provides no chronological framework for this period. Index markers, such as Montell, Marcos, Lange, Williams, Castroville, and Marshall point types are used to identify this component. Castroville and Marshall points are more predominant in the earlier portion of this phase. San Marcos components are most evident at the Hawes Site and sites 41WM57 and 41WM73. Previously investigated sites such as the John Ischy Site (Sorrow 1969) and site 41WM88 (Sorrow 1973) also exhibit components of the San Marcos Phase.

A total of 37 lithic tools from site 41WM56 and 20 from site 41WM73, excluding the projectile points, were collected during excavation of the San Marcos component in the North Fork Reservoir. Tool and debitage densities during this time period are intermediate to high, even for this small sample (Table 16.5-1).

Nearly half of the tool assemblage in the San Marcos component is composed of biface fragments (44%), while 21% are retouched pieces. In general, retouched pieces are unilaterally re~~touched;~~ but at site 41WM73 half of the retouched pieces are bilaterally retouched. When one excludes the above two tool classes, scrapers are the largest tool class (restricted % = 20). Half of the scrapers are fragments, and the others are single scrapers, both end- and sidescrapers. Complete bifaces and notched pieces occur in equal numbers (restricted % = 15). All of the latter are single notched flakes. All complete bifaces were found at site 41WM56 and are predominantly medium to large, subtriangular to triangular tools. Truncations (restricted % = 10) include one single distal truncation and one of the rare double truncations found during this project. Boring tools (restricted % = 15) are represented by one graver, one borer and one drill. All other tool classes are represented by only one tool each (denticulates, backed pieces, burins, gouges and axes). Cores were not recovered from San Marcos components in the North Fork Reservoir.

Distinct features for the San Marcos components were recognized only at the Hawes Site. Shallow, basin-shaped hearths and flat, informal clusters of burned rock (also hearths) were isolated in certain areas. Elsewhere, diagnostic artifacts of the San Marcos Phase were included in the massive accumulations of burned rock. At site 41WM57 point types of the Round Rock/San Marcos transition were found associated with isolated clusters of burned rock at the periphery of the more massive lens of burned rock. The San Marcos Phase artifacts were found in the upper levels of the mounds at both sites 41WM57 and 41WM73. Elsewhere, at the John Ischy Site, these same diagnostics were predominant within the major accumulation of burned rock (Sorrow 1969: 50).

Although the volume of site matrix which could be designated to the San Marcos Phase is relatively low compared to the prevous Round Rock

TABLE 16.5-1: Totals, percentage, and restricted percentage for the tools from the San Marcos Phase, North Fork Reservoir.

	Site 41WM56			Site 41WM73			North Fork Reservoir		
Tool Class	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %
Scrapers	3	8.11	23.08	1	5.00	14.29	4	7.02	20.00
Denticulates	1	2.70	7.69				1	1.75	5.00
Notches	1	2.70	7.69	2	10.00	28.55	3	5.26	15.00
Gravers	1	2.70	7.69				1	1.75	5.00
Borers	1	2.70	7.69				1	1.75	5.00
Drills				1	5.00	14.29	1	1.75	5.00
Truncations	1	2.70	7.69	1	5.00	14.29	2	3.51	10.00
Backed Pieces	1	2.70	7.69				1	1.75	5.00
Burins				1	5.00	14.29	1	1.75	5.00
Retouched P.	8	21.62	-	4	20.00	-	12	21.07	-
Bifaces	3	8.11	23.08				3	5.26	15.00
Biface Frags.	16	43.26	-	9	45.00	-	25	43.88	-
Gouges				1	5.00	14.29	1	1.75	5.00
Axes	1	2.70	7.69				1	1.75	5.00
TOTAL	37	100.00	99.99	20	100.00	100.00	57	100.00	100.00
Restricted Total	13			7			20		

Phase, occupational intensity does not appear significantly lower. Densities of tools and debitage are well within the range of variability of the preceding phase (Table 16.9-2). The lower volume of site matrix may be related directly to the shorter time span of the San Marcos Phase.

The same processes of midden accumulation continued and the same variety of flora and fauna continued to be utilized. The minimal samples of faunal elements however, possibly reflect a decline in resource availability or a less intensive exploitation of that availability. On the other hand, small sample sizes may be skewing the impression of this period. Discrete components of this phase are relatively rare in the North Fork assemblages. The mixed zones of sites, such as 41WM56, include numerous diagnostic artifacts of this phase and more abundant faunal samples. The adaptive strategy of this period, therefore, probably represents a continuation of the preceding phase. The available data do not indicate that environmental conditions were changing. It is apparent, however, that at the end of this phase the accumulation of the burned rock middens declines drastically.

16.6 Twin Sisters Phase

Although the diagnostic projectile point types of the Twin Sisters Phase (Darl, Frio, Fairland, and Ensor) are found at many of the previously occupied sites, the Hawes Site is the only site which contains a recognizable Twin Sisters component. Sites 41WM53 and 41WM328 are occupied for the first time during this phase. Fortunately, both sites yielded sufficient radiocarbon samples to date portions of these occupations. Although site 41WM53 was occupied earlier, the earliest dated context is 1620 ± 70 B.P. (Tx-2539). Apparently, site 41WM328 was occupied during the same time span, for dates of 1460 ± 80 B.P. (UGa-2481) and 1610 ± 165 B.P. (UGa-2483) were obtained from hearths near the upper limits of the Twin Sisters component. Occupation of site 41WM53 continued much later, for dates of 1153 ± 95 B.P. (UGa-2471) and 1260 ± 150 B.P. (UGa-2484) were obtained from hearths with Darl and Scallorn points in stratigraphic association. The Twin Sisters/Austin Phase transition may be indicated by this association.

A total of 106 lithic tools from site 41WM53, 134 from site 41WM56 and 63 from site 41WM328, excluding the projectile points, were collected from excavations of Twin Sister contexts at the North Fork Reservoir. Tool and debitage densities are medium to low, except at site 41WM56 where they are very high (Table 16.6-1).

Nearly half of the tool assemblage in this Twin Sisters component consists of biface fragments (43%). Retouched pieces are relatively very low with only 19% of the assemblage. Most of the retouched pieces are unilaterally retouched flakes. When excluding the above two classes,

TABLE 16.6-1: Totals, percentage, and restricted percentage for the tools from the Twin Sister Phase in the North Fork Reservoir.

Tool Classes	Site 41WM53			Site 41WM56			Site 41WM328			North Frok Reservoir		
	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %
Scrapers	4	3.77	13.79	7	5.22	12.50	4	6.35	13.33	15	4.95	13.04
Denticulates				2	1.49	3.57	6	9.52	20.00	8	2.64	6.96
Notches	7	6.60	24.14	13	9.70	23.21	2	3.17	6.67	22	7.26	19.13
Gravers				2	1.49	3.57	1	1.59	3.33	3	.99	2.61
Borers	1	.94	3.45							1	.33	.87
Perforators	1	.94	3.45							1	.33	.87
Drills				2	1.49	3.57				2	.66	1.74
Truncations	4	3.77	13.79	4	2.99	7.14				8	2.64	6.96
Backed Pieces	4	3.77	13.79	5	3.73	8.93	3	4.76	10.00	12	3.96	10.43
Burins	5	4.72	17.24	14	10.45	25.00	9	14.29	30.00	28	9.24	24.34
Composite	1	.94	3.45							1	.33	.87
Retouched P.	31	29.25	-	17	12.69	-	10	15.87	-	58	19.14	-
Bifaces	2	1.89	6.90	6	4.48	10.72	2	3.17	6.67	10	3.30	8.70
Biface Frags.	46	43.40	-	61	45.52	-	23	36.52	-	130	42.91	-
Axes							1	1.59	3.33	1	.33	.87
Scaled/Batt.				1	.75	1.79	2	3.17	6.67	3	.99	2.61
TOTAL	106	100.00	100100	134	100.00	100.00	63	100.00	100.00	303	100.00	100.00
Restricted Total	29			56			30			115		

burins form the single most important tool class in the North Fork Reservoir (restricted % = 24). Single angle burins on snap and double angle burins on snap make up about one third of the burins. Another important subtype is the dihedral burin. The other burin subtypes were present, but in low numbers. Next are the notched pieces (restricted % = 19), mostly single notched flakes, few with additional continuous retouch. Multiple notches are quite frequent, with no preference for either adjacent or non-adjacent notches. The scrapers (restricted % = 13) are mostly single sidescrapers, but subtypes in this scraper type and others vary significantly from site to site. Single sidescrapers are the only constant, the other scraper types are only represented by one or two tools. Backed pieces (restricted % = 10) were mostly backed steeply along one complete edge. This edge outline can be either straight, convex or concave, without any marked preference. There is only one partially and one double-backed pieces. Complete bifaces and preforms (restricted % = 9) are moderately well represented. Complete bifaces were not found at site 41WM328; at the other two sites they are mostly medium to large artifacts. Preforms were not found at site 41WM53; the ones from the other sites are fairly intensively bifacially retouched tools. Truncations and denticulated pieces occur in equal numbers (restricted % = 7 each). Truncations are lacking at site 41WM328, as are denticulated pieces at site 41WM53. Unusually, the truncated pieces are predominantly proximal truncations, either by obverse or inverse retouch; one artifact is a double truncation. The denticulates are mainly simple denticulated flakes; one tool has a ventral preparation, and another tool was made on a blade. Boring tools are sparcely represented (restricted % = 6 in total). Borers, perforators and drills are very rare; most boring tools are gravers, several subtypes of which were represented by one artifact only. Scaled and battered pieces are present; composite tools and axes are very rare.

A total of 15 cores was found in Twin Sisters context in the North Fork Reservoir. Only one came from site 41WM53, the others were in equal numbers from sites 41WM56 and 41WM328. They are predominantly multiple platform cores (9 or 60%), followed by single platform cores (4 or 27%) and double platform cores (2 or 13%). No other core types were recovered.

An additional 135 stone tools were recovered from site 41WM53 in a mixed or Twin Sisters/Austin Phase transitional component. Over 75% of this assemblage was made up of retouched pieces (38%) and biface fragments (39%) in nearly equal proportions. This is in contrast to the Twin Sisters component proper, where biface fragments are vastly dominant. Such a shift in the proportion of retouched pieces and biface fragments may be directly related to the increased intensity of occupation of this site and the probable change in site function rather than a temporal trend in the overall adaptive technology.

When one excludes the above two tool classes, notched pieces form the most important tool class (restricted % = 39). They are mostly single notched flakes. Burins and truncations occur in equal numbers (restricted % = 13 each). The burins are mostly single angle burins, all truncations are distal, made by either dorsal or ventral retouch. Scrapers (restricted % = 10) are few, as are backed pieces (restricted % = 6) and boring tools (restricted % = 6). All of the latter are drills. Complete bifaces and preforms (restricted % = 10) are small and intensively retouched artifacts. One scaled and battered pieces also occur, but all other tool classes are absent. The only core recovered in this context is a single platform core.

Site location changed during this phase. Terrace edges near the stream channel (41WM328, 41WM56) or levee formations (41WM53) became the favored site locations. Distinct occupational episodes are more easily recognized within these sites. Whether this is due to more lengthy periods between site visits or the increased likelihood of flood deposition at these sites is uncertain. The lack of sufficient radiocarbon dates for determining sedimentation rates precludes such a determination. The low density of cultural debris in most levels, however, indicates ephemeral occupations.

Shallow basin-shaped hearths and informal clusters of burned rock are again characteristic features. Many of the informal clusters of this phase, however, are quite small (<50 cm in breadth) and are often found in close association with one another. The particular function of these informal clusters is unknown. The additional presence of irregularly formed areas of heat altered soil (unique to site 41WM328) also is perplexing.

Near the end of this period, massive burned rock accumulations are again present. Intensive utilization of a small area of site 41WM53 resulted in the production of a thick lens of burned rock. Isolated informal clusters of burned rock and basin-shaped hearths were recognized. The apparent repeated removal of spent burned rocks from the hearths contributed to the burned rock accumulation. Charred acorn fragments were found throughout this accumulation.

The floral and faunal remains recovered from this component of the sites reveal that a variety of resources continue to be exploited. The remains of acorns, pecans, walnuts, <u>Chenopodium</u> sp., and hedgehog cactus were recovered from the hearths. Deer, rabbit, bison, turtle, and fish comprise the fauna utilized.

16.7 Austin Phase

Within the North Fork Reservoir, elements of the Austin Phase (Scallorn arrow points) are found in significant quantities only at

sites 41WM53, 41WM328, 41WM404, and 41WM56. Stratigraphically discrete components are present at sites 41WM53 and 41WM328 only. One of the hearths from the Austin component at site 41WM328 yielded a date of 1290 ± 100 B.P. (UGa-2470). This date and the dates of 1155 ± 95 B.P. (UGa-2471) and 1260 ± 150 B.P. (UGa-2484) associated with the earliest Scallorn specimens at site 41WM53 indicate that the arbitrary beginning date of 1250 B.P. for the Austin Phase is appropriate for the North Fork area.

A total of 49 lithic tools from site 41WM53 and 8 from site 41WM328, excluding projectile points, were collected during excavation of the Austin components in the North Fork Reservoir. Tool and debitage densities drop significantly, and it is clear from the tool totals given above that there are few for this cultural component. One has to keep that in mind when analyzing the results of the tool typology (Table 16.7-1).

Biface fragments still form the largest tool class for this cultural component for they comprise 46% of the tool assemblage. Retouched pieces are also very important and account for 32% of the tools. The retouched pieces are mainly unilaterally retouched flakes. When excluding the above two tool classes, notched pieces mainly single notched flakes are most numerous (restricted % = 23). Truncations and denticulates (restricted % = 15) occur in equal numbers. One of the denticulates is a serrated piece, the only denticulate recovered during excavations at site 41WM53. Complete bifaces (restricted % = 23) were recovered from this component, but no complete preforms. One backed piece, one graver and one scraper were found. Interesting is the total absence of burins during this time period in the North Fork Reservoir, since they are so prominent during the preceding Twin Sisters Phase. Only two cores were found; a single platform core recovered at site 41WM53 and a subdiscoidal core from site 41WM328.

Feature morphology does not change during this phase. Basin-shaped hearths and informal clusters of burned rock, also hearths, are present at site 41WM328. Numerous hearths may have been present at the Hawes Site, but recent agricultural activities have probably destroyed them. Interestingly, the horizontal expanse of these occupations is quite restricted at all of the sites. Small group size and/or a limited number of reoccupations of the sites may have been a contributing factor.

A less diverse diet is indicated for this period. Deer, rabbit, turkey, and fish are minimally represented. The presence of numerous faunal elements in the disturbed upper levels of the Hawes Site, however, suggests that the small samples from sites 41WM53 and 41WM328 may be biased. Macrobotanical remains from the hearths demonstrate that acorns, walnuts, and pecans are still utilized.

A decline in occupation in the North Fork drainage apparently continued through this phase. Whether the local environment had deteriorated further at this time is not apparent from the available data. The

TABLE 16.7-1: Totals, percentage, and restricted percentage for the tools from the Austin Phase, North Fork Reservoir.

	Site 41WM53			Site 41WM328			North Fork Reservoir		
Tool Classes	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %
Scrapers	1	2.04	9.09				1	1.75	7.69
Denticulates	1	2.04	9.09	1	12.50	50.00	2	3.51	15.38
Notches	3	6.12	27.28				3	5.26	23.08
Gravers	1	2.04	9.09				1	1.75	7.69
Truncations	2	4.08	18.18				2	3.51	15.38
Backed Pieces	1	2.04	9.09				1	1.75	7.69
Retouched P.	16	32.65	-	2	25.00	-	18	31.59	-
Bifaces	2	4.08	18.18	1	12.50	50.00	3	5.26	23.08
Biface Frags.	22	44.91	-	4	50.00	-	26	45.62	-
TOTAL	49	100.00	100.00	8	100.00	100.00	57	100.00	99.99
Restricted Total	11			2			13		

greater visibility of Austin components in sites located in the Brazos River drainage to the north however, suggests that other regions may have been more attractive during this period.

16.8 Toyah Phase

The Toyah Phase is represented by the presence of diagnostic artifacts, Perdiz and Fresno points and pottery, at two sites in the North Fork Reservoir. The Hawes Site (41WM56) and the Barker Site (41WM71) yielded these artifacts from the disturbed plowzone. Consequently, no associated features or radiocarbon dates were recovered. A third site, 41WM404, yielded Perdiz points in a very mixed Post-Archaic component. From the relative temporal position of these diagnostic artifacts elsewhere, it is assumed that these ephemeral occupations occurred between 650 and 150 B.P.

The ceramics from the Hawes and Barker Sites are not of one homogeneous lot. The small sample from the Hawes Site (two sherds) and a portion of the sample from the Barker Site (Sorrow 1970: 14-17) exhibit construction and decorative techniques which were probably introduced through contact with areas to the southeast. The remainder of the sherds from the Barker Site resemble Leon Plain ceramics (Suhm, Krieger, and Jelks 1954: 386) which are thought to be indigenous to Central Texas.

The restricted horizontal expanse of these occupations and the limited amount of cultural material recovered from the Barker Site probably reflect very brief occupations in the North Fork drainage. The high proportion of scrapers from the Barker Site (Sorrow 1970: 9-11) may indicate that the site served as a specific processing site rather than as a generalized foraging station. However these sites functioned, it is apparent that the North Fork drainage was utilized infrequently.

16.9 Summary

Chronology

In Central Texas, the chronology of archaeological sites relies heavily on the presence or absence of diagnostic projectile point types. The chronology of the North Fork Reservoir also is based on the relative stratigraphic positions of diagnostic projectile points and ten radiocarbon dates (Table 7.1-1). Although the majority of these dates pertain to the Twin Sisters and Austin Phases, the remainder provide a much needed framework for the Clear Fork and Round Rock Phases.

Based on presently available data, prehistoric occupation of the North Fork drainage extends from approximately 8000 B.P. to 150 B.P. The stratigraphic relationships of the recovered projectile points largely

substantiate the presently accepted chronological scheme for Central Texas (Prewitt 1976 1981; Weir 1976; Patterson 1977). The stratigraphic positions of some index markers from the North Fork assemblages, however, differ from the currently accepted scheme. These stratigraphic relationships, together with the available radiocarbon dates, provide a more realistic chronological construct for the eastern periphery of the Edwards Plateau (Table 16.9-1).

The greatest discrepancies between the presently available chronology and the North Fork data are in the San Geronimo and Clear Fork Phases. Wells points are clearly a part of the earlier San Geronimo tool kit rather than that of the Clear Fork component. The previously defined Hoxie point and the newly defined Groups 10, 12, and 13 are also a part of the San Geronimo assemblages. Bell points, on the other hand, were not recovered from the North Fork assemblages. Stylistic variability for this lengthy phase is apparently great. Unfortunately, no radiocarbon dates were obtained for these diagnostic elements.

Radiocarbon dates however, are associated stratigraphically with diagnostic artifacts of the Clear Fork Phase. Several radiocarbon dates indicate that Bulverde, Nolan, and Group 14 point types are the predominant projectile point styles between 4000 and 5000 B.P. Even though other minor styles such as Travis, "Tortugas", and Groups 2, 4, 5, 7, and 11 are also represented, there is much less variability of blade and stem form during this phase.

Chronologically, the subsequent Round Rock Phase is not well delineated anywhere in Central Texas. A single date of 3225 ± 75 B.P. (UGa-2480) documents the initial presence of the Pedernales point type at the Hawes Site (41WM56). Whether this pattern is repeated at the other sites is unknown. Pedernales points are not the numerically dominant projectile point style of these sites in the North Fork Reservoir as is apparently the case for sites to the south and west on the Edwards Plateau (Weir 1976). The stylistic variability during this phase also may be less homogeneous than previously depicted (Weir 1976), for other projectile point forms (Castroville, Marshall) are consistently associated with Pedernales points. Such associations, however, may be the result of the complex accumulation processes of the burned rock middens rather than contemporaneity within the prehistoric behavioral context.

The remainder of the projectile points and radiocarbon dates are very consistent with the presently recognized chrnological construct for Central Texas. Dates from sites 41WM53 and 41WM328 document the presence of Fairland/Ensor points between 1600 and 1250 B.P. Darl points are present from at least 1450 to 1250 B.P. Scallorn points, diagnostic of the Austin Phase, overlap with these diagnostics of the Twin Sisters Phase at approximately 1250 B.P. (Table 16.9-1). Significantly, Scallorn points appear earlier in the North Fork drainage than they do to the southwest on the Edwards Plateau (Hester, 1973).

Table 16.9-1

Years B.P.	Phase	Index Markers: Central Texas*	Index Markers: North Fork
150-650	Toyah	Perdiz	Perdiz
		Clifton	Leon Plain pottery
650-1250	Austin	Scallorn	Scallorn
1250-1750	Twin Sisters	Darl	Darl
		Frio	Frio
		Ensor	Ensor
		Fairland	Fairland
			Fairland/Ensor
1750-2600	San Marcos	Marcos	Marcos
		Montell	Montell
		Williams	Williams
		Castroville	Castroville
		Marshall	Marshall
2600-4000	Round Rock		Castroville
		Marshall	Marshall
		Pedernales	Pedernales
		Bulverde	Bulverde
4000-5000	Clear Fork	Bulverde	Bulverde
		Nolan	Group 14 **
		Travis	Nolan
		Wells	Groups 2,4,5,7,11 **
		Tortugas	Travis
			"Tortugas"
5000-7000	San Geronimo	Angostura	Hoxie
		Gower	Wells
		Uvalde	Gower
		Martindale	Uvalde
		Bell	Martindale
		Tortugas	"Tortugas"
			Groups 10,12,13 **
7000-8500	Circleville	Angostura	Angostura
		Meserve	Meserve
		Golandrina	Golandrina
		Scottsbluff	

* (Patterson 1977)
** (Chapter 14.1)

Diagnostic artifacts of the final prehistoric Toyah Phase, Perdiz points and Leon Plain pottery, are present within the North Fork assemblages. Fresno points and ceramics which appear to represent contact with areas to the southeast also are found.

Artifact Assemblages

The artifact assemblage utilized by the prehistoric occupants of the North Fork drainage remains remarkably consistent through time. The relative importance of a particular tool class may have fluctuated from phase to phase, but the overall diversity of the tool kit is relatively constant. Once an efficient adaptation was developed for the utilization of the North Fork environment, there was apparently no dramatic need for the prehistoric occupants to alter their tool kit.

A similar conservatism is noted in the lithic reduction technology associated with the production of these tool assemblages. An examination of the lithic debitage presented earlier (Chapter 14.4) revealed that the lithic reduction technology remained the same throughout the Archaic period. The technology of the Post-Archaic period also appears to be very similar, although, the smallness of the available data base does not allow definite conclusions at this time. Nevertheless, a conservative technological tradition is indicated during the 8000 years of occupation of the North Fork Valley.

Biface fragments and retouched pieces are the dominant tool classes throughout the occupational sequence of the North Fork drainage. The biface fragments represent broken tools and rejects from tool production. Tool production was apparently an important activity at all sites in the North Fork Reservoir. Hammerstones and cores are present in most site components. The relatively low number of cores, however, indicates that much of the primary lithic reduction took place elsewhere. The immense scatters of lithic debitage, tested cores, and slabs of raw material along the upland ridges probably represent this activity.

The predominance of the retouched pieces, tools of expediency, together with the occurrence of a wide variety of other tool classes represent a very generalized tool kit. With the significant increase of scrapers and groundstone tools during the Clear Fork Phase, a tool kit had been developed to enable the efficient utilization of the entire range of available resources. A very diffuse foraging economy is indicated by the tool assemblages for the entire cocupational sequence within the North Fork valley. Although the samples of the Austin and Toyah Phases are small, the only noticeable changes in the adaptive technology are the introduction of the bow and arrow around 1250 B.P. and the minimal utilization of ceramics after 650 B.P.

Settlement/Subsistence Patterns

From a diachronic perspective trends in occupational intensity, site location, and differentiation in site function are perceivable in the North Fork assemblages. During the Circleville and San Geronimo Phases, the densities of lithic debitage and tools are extremely low for the long time span involved (Table 16.9-2). This low density of cultural materials and the presence of simple informal hearths indicate that occupation of a given site was ephemeral. The broad horizontal expanse of these components and the superpositioning of hearths and associated material also denote the recurrent utilization of a site locality. The diversity of the tool assemblages and the associated faunal resources (aquatic, woodland, prairie) suggests that these sites functioned as ephemeral foraging camps for small bands of hunter-gatherers rather than as specialized hunting camps.

This pattern of exploitation continues during the earlier portions of the Clear Fork Phase. More formal basin-shaped hearths also appear during this time period. Around 4000 B.P., however, the intensity of occupation and perhaps the function of some of the sites changes. Lithic debitage and tool densities increase significantly (Table 16.9-2 note that these figures are for the entire Clear Fork component) and massive accumulations of burned rock begin to form. Changing sedimentation rates during this period could have affected such densities without any real change in occupational intensity. However, the continued presence of these sites at the back of the terraces near the upland slope suggests that sedimentation rates may have been fairly stable throughout the Early Archaic period. The increased diversity of food resources, both faunal and floral, further suggests the presence of a larger population fully exploiting all available resources. The first notable presence of floral remains and groundstone tools occurs during this phase. Therefore, it seems reasonable to postulate that the pressures of an increasing population within the San Gabriel River valley resulted in the more frequent reoccupation of sites during the latter part of the Clear Fork Phase.

Subsistence activities also may have varied among the sites at this time. Sites such as 41WM57, 41WM304, and 41WM73 which represent the initiation of the classic burned rock middens exhibit a degree of specialization not evident at the Hawes Site (41WM56). The Hawes Site with its high diversity of features, floral and faunal resources, and associated lithic tools may represent a more generalized base camp during this period.

This settlement/subsistence pattern of the late Clear Fork Phase continues as the adaptive strategy during the following Round Rock and San Marcos Phases. During these phases the massive accumulations of burned rock continue to grow. Informal clusters of burned rock, basin-shaped hearths, and deeper pit hearths or ovens are the most common

Table 16.9-2
Tool and Debitage Densities of Components from
Sites of the North Fork Reservoir

Components	Sites	Excavated Volume m^3	Tool Density N/m^3	Debitage Density N/m^3	Tool/Debitage Ratio
San Geronimo	41WM56	11.5	17	1893	1:111
	41WM57	1.7	24	1021	1:43
	41WM304	2.05	17	1503	1:88
Clear Fork	41WM56	12.1	50	5904	1:118
	41WM57	3.4	12	587	1:49
	41WM73	3.0	13	996	1:77
	41WM304	3.9	34	3322	1:98
Round Rock	41WM56	2.8	70	4654	1:66
	41WM57	2.6	31	1533	1:49
	41WM73	8.7	22	1224	1:56
	41WM304	2.4	23	1828	1:79
San Marcos	41WM56	1.1	45	3065	1:68
	41WM73	1.2	25	2448	1:98
Twin Sisters	41WM53	11.4	13	1344	1:103
	41WM56	3.6	51	4395	1:86
	41WM328	3.5	24	1570	1:65
Austin	41WM53	2.2	31	1421	1:46
	41WM328	.6	17	455	1:27

features of the Round Rock Phase. These same hearth features, except for the deeper pit hearths, were also recognized in the San Marcos components. The utilization of the available floral and faunal resources remains quite diverse. Exploitation of the aquatic environment declines, but a greater reliance on grassland species is evident. Occupational intensity as reflected by the densities of lithic debitage and tools remains high throughout these periods (Table 16.9-2).

Although previously occupied sites continue to be utilized during the Twin Sisters Phase, new site locations near the stream channel occur for the first time. Occupational intensity at these site locations appears to be significantly lower, although the sedimentation environments (i.e., greater sedimentation rates) of these sites may have artificially affected artifact densities (Table 16.9-2) compared to those of the Hawes Site (41WM56). During this phase, some sites, such as 41WM73 and 41WM304, are no longer important while others, 41WM56 and 41WM57, continue to be intensively utilized. The relationship between the occupations of this phase and the massive accumulations of burned rock at these sites is unclear. Nevertheless, the accumulation of burned rock at site 41WM53 at the end of the Twin Sisters Phase indicates that the behavioral processes responsible for such accumulations were still a part of the cultural complex during this phase. The level of intensity of such processes, however, appears to have significantly decreased compared to that of the previous phases.

The number of sites, the size of those sites, and the associated densities of debitage and tools (Table 16.9-2) of the following Austin and Toyah Phases denote a continued decline in the prehistoric utilization of the North Fork drainage. Previous investigators (Moore, Shafer, and Weed 1978: 78) have suggested that the relatively short time span of these phases, when compared to the time span of the Archaic period, creates a false impression of the relative levels of occupatinal intensity. Such is not the case, however, for the time span of the Austin and Toyah Phases combined (>1000 years) equals over 80 percent of the time span of the preceding Twin Sisters and San Marcos Phases. Therefore, the decline in the utilization of the North Fork drainage is very real. Evidently, other locales in Central Texas were more attractive during this period.

Paleoenvironment

Although pollen investigations in the North Fork drainage have been unproductive (Chapter 15.4), the vertebrate and invertebrate fauna and the macrobotanical remains denote a relatively consistent environmental situation throughout the occupational history of the valley. The relatively minor temporal fluctuations in the vertebrate fauna indicate that climatic changes were not radical enough to significantly alter subsistence strategies. A reliable data base is available only for the period from approximately 6000 to 1250 B.P. (San Geronimo through Twin Sisters Phases).

During the San Geronimo and Clear Fork Phases the utilization of aquatic species indicates that sufficient moisture is present. The gastropod fauna (Chapter 15.6) do not necessarily confirm this interpretation; although, an overly dry environment is not indicated. The appearance of certain species of gastropods (i.e., H.o. tropica) in the Clear Fork components suggests that overstory vegetation was present in areas where it had not been during the earlier San Geronimo Phase.

The presence of hackberry seeds, acorns, pecans, Chenopodium sp., and Juniperus sp. in the Round Rock components indicates floral communities which are similar to those of today. Exploitation of the available faunal resources remained quite diverse (Chapter 15.7) during this period. Although aquatic resources are still utilized, their relative importance with respect to the grassland and woodland species is signficantly reduced (Fig.15.7-3). The relative increase of grassland species, such as pronghorn antelope and bison, in conjunction with the decreasing occurrence of aquatic species may indicate a drier environment. The relative increase of certain gastropod species (P. mooreana and P. berlanderiana) which prefer a drier habitat (Chapter 15.6) correlates positively with these relative increases and decreases. Although such data are not overwhelmingly conclusive, a relative drying trend may be indicated.

During the following San Marcos and Twin Sisters Phases, the continued availability of a wide variety of faunal and floral resources indicates no dramatic changes in the local environment. The gastropod fauna similarly reveal no dramatic environmental changes. During the earlier Twin Sisters Phase occupations at site 41WM53, a mesic, dense understory vegetation is indicated by the presence of Anosuispira strongylodes and Mesomphix friabilis. Later during this period, however, species preferring a drier habitat are dominant. At site 41WM328, the gastropod fauna reflect an open terrace environment subject to frequent flooding. These data are suggestive that the local environment was relatively dry. The decreased level of occupational activity during this phase indicates that the carrying capacity of the North Fork drainage may have been reduced. Alternatively, adjacent areas may have been more attractive at this time. Unfortunately, the present data base provides no conclusive answer.

The continued decline in the prehistoric utilization of the North Fork drainage suggests that environmental conditions may have been deteriorating. Although no data relevant to this problem were available in the North Fork assemblages, recent investigations in the proposed Richland Creek Reservoir southeast of Corsicana suggest that drought conditions were present after 1000 B.P. (Raab, McGregor, and Bruseth 1981: 553-578). Whether such conditions were widespread in Central Texas is unclear, for examination of the gastropod fauna from the Hog Creek assemblages in Bosque and Coryell Counties revealed a period of increasing moisture during this same time span (Henry, Kirby, Justen, and Hays 1980: 504-535). Admittedly, all of these conclusions

are tentative. Nevertheless, the greater visibility of Austin and Toyah Phase components in sites located to the north of the North Fork drainage suggests that other locales of Central Texas were more attractive during this period.

17.0 The Archaeology of Granger Reservoir

17.1 Circleville Phase

Components of this phase are present at only two sites in the Granger Reservoir; the Loeve Site (41WM133) and the Tombstone Bluff Site (41WM165). The diagnostic elements of this phase (Angostura, Golondrina, and Meserve projectile point types) are inter-mixed with diagnostic elements of other phases of the Early Archaic and Paleo-Indian periods at the Tombstone Bluff Site. Although diagnostic artifacts of the Circleville Phase dominate this assemblage, caution must be exercised in presenting such an assemblage as characteristic of this phase. The Loeve Site provides the only cultural materials of this phase which are in a primary context.

In the Stratum III sediments of the Loeve Site, Angostura-like points are stratigraphically associated with radiocarbon dates of 9650 ± 910 B.P. (Tx-3405) and 8500 ± 130 B.P. (Tx-2675). The later date was obtained from a hearth in the Stratum III sediments (Moore, Shafer, and Weed 1978:43). The recent investigations of this same hearth (Appendix J) revealed that the feature was actually two superimposed hearth basins. Since the most recent sample from this hearth yielded a date with such a large sigma value, the 8500 B.P. date is considered the most reasonable estimate of this occupation. Eddy's (1973:35) previous investigation of the site demonstrated that the Stratum III deposits were laid down prior to 7000 B.P., for a date of 6900 ± 110 B.P. (Tx-805) was obtained from the base of Stratum II and a date of 7000 ± 160 B.P. (Tx-802,803) from a hearth within the upper Stratum III deposits. Although no diagnostic artifacts were associated with these later dates, the dated contexts of Angostura, Golondrina, and Meserve specimens from Southwest Texas (Word and Douglas 1973; Hester 1978; Dibble and Lorrain 1967; Sorrow 1968) suggest a probable time frame for this phase is 7000 to 9000 B.P. As noted earlier, this time frame needs to be substantiated by other dates from primary contexts within Central Texas.

The limited tool assemblage recovered from the Loeve Site (Appendix I) consists of projectile points (8.3%), bifaces (12.5%), notches (4.2%), retouched pieces (25%), hammerstones (29.2%), gravers (4.2%), and scrapers (4.2%). Clear Fork gouges, although not present at the Loeve Site, are represented in the assemblage from the Tombstone Bluff Site. Lithic reduction was apparently a primary activity at the Loeve Site for the occurrences of both debitage (n=1141) and hammerstones (n=7) are quite high for the area sampled.

Cores and core fragments (n=21) are also well represented. Most are small cobbles which have been fully utilized. No large discoidal cores are present.

Features of this phase were recovered only from the Loeve Site. They consist of basin hearths, burned clay/charcoal pits, informal burned rock scatters, and mussel shell concentrations (Appendix J). The stratigraphic relationships of the features suggest that the site was repeatedly occupied for short periods of time. Other than the molluscan remains, there is no evidence of the food resources utilized from either site. The complete lack of features and burned rock from the Tombstone Bluff Site indicates that the range of activities conducted there was even more restricted than that of the Loeve Site. Prewitt (Appendix J) suggests that the Tombstone Bluff Site served as a hunting and lithic procurement/tool production station. Lithic procurement and tool production are also important at the Loeve Site, although the duration of occupation was apparently longer.

17.2 San Geronimo Phase

The only component of this phase that has been investigated to any extent within the Granger Reservoir is that of the Cervenka Site (41WM267). Diagnostic projectile point types of this phase are also present at the Tombstone Bluff Site (41WM165) and site 41WM21. These diagnostic elements consist of Hoxie, Andice, Uvalde, Wells, and Tortugas points. Previously undefined Groups 9, 10, 12 and 13 are also present. The stratigraphic association of Hoxie Points and a radiocarbon date of 4330 ± 420 B.P. (R1-1086) provides an arbitrary, terminal boundary of approximately 5,000 B.P. for this phase. The only other date for this component of the Cervenka Site is that of 4970 ± 90 B.P. (Tx-3684) which when calibrated provides a date of 5738 ± 139 B.P. The only projectile points occurring stratigraphically deeper than this date is a Group 12 specimen. All of the other diagnostic elements occur above the stratigraphic position of this date. Consequently, the projected appearance of this phase at 7,000 B.P. (Prewitt 1976; Weir 1976; Patterson 1977) remains largely conjectural (Table 7.1-1).

A total of 134 tools was collected from the San Geronimo component (Table 17.2-1): site 41WM267. The assemblage is unusual for the retouched pieces (50.54%) are present in much higher numbers than the biface fragments (12.50%). Together they make up more than half of the tool kit. When excluding those two tool categories, the notched pieces are the most important tool class (restricted % = 28). There is a wide variety in notched pieces subclasses, but single notches on flakes are predominant. There are two tools made on blades. Interesting also is the presence of three meganotches. Burins and denticulates are the next most important class (restricted % = 13). There is a high proportion of serrated pieces, as many as simple denticulated flakes. Burins also occur in a wide variety; they are mostly angle burins, but dihedral, transversal and oblique burins

TABLE 17.2-1: Totals, percentage and restricted percentage for the tools from the San Geronimo Phase in the Granger Reservoir (site 41WM267 only)

	Site 41WM267		
	#	%	Restr.%
Scrapers	5	2.72	7.35
Denticulates	9	4.89	13.24
Notched p.	19	10.33	27.94
Gravers	4	2.17	5.88
Borers	2	1.09	2.94
Truncations	5	2.72	7.35
Backed p.	4	2.17	5.88
Burins	9	4.89	13.24
Retouched p.	93	50.55	-
Bifaces	6	3.26	8.83
Biface frags.	23	12.50	-
Axes	4	2.17	5.88
Chopping Tools	1	.54	1.47
TOTAL	184	100.00	100.00
Restr.TOTAL	68		

occur also. Scrapers and truncations occur in equal numbers (restricted % = 7). Interestingly, there are more proximal than distal truncations, although all were made by dorsal retouch. Whole bifaces and preforms (restricted % = 9) are all large to medium size tools. There is also a high percentage of axes (restricted % = 6), all with a straight bit profile. The boring tools are mostly gravers (restricted % = 6) with some borers (restricted % = 3). Most were made on a flake edge, although a graver on axis and an oblique borer also occur. One chopping tool was also present in this assemblage.

A relatively high number of cores was found. Most are multiple platform cores (36%), double platform cores (25%) or triple platform cores (21%). Subdiscoidal and wedge cores are few in number.

Site 41WM267 has a relatively high number of tools, but could not be compared with another site in the Granger reservoir, because it is the only San Geronimo component excavated. At this point one cannot be certain that this sample is representative of the San Geronimo Phase, especially when one notes the remarkable similarity through time of the tool assemblages from this site.

Features of this phase consist of informal clusters of burned rock, basin-shaped hearths, and concentrations of ash and heat altered soil. The density of lithic debitage and tools associated with these features is extremely low. Occupancy of the Cervenka Site was very ephemeral. Nevertheless, the stratigraphic positioning of the features indicates that the site was reoccupied frequently.

The faunal assemblage of this component denotes a diffuse foraging subsistence strategy, with aquatic, grassland, and woodland species exploited (Chapter 15.7). Avian elements, such as Prairie chicken, turkey, and quail, are well represented. Bison bones are present in the deeper levels of this component, while pronghorn antelope are present in the upper levels. It is clear that prairie species dominate the faunal assemblage for deer and rabbit comprise only 9 and 12 percent, respectively, if the identified species.

17.3 Clear Fork Phase

Within the Granger Reservoir only one site, the Cervenka Site (41WM267), yielded a significant Clear Fork component. Elsewhere, at the Bryan Fox Site, the Clear Fork component was only minimally tested. Diagnostic projectile point types of the Clear Fork Phase also were recovered from the Tombstone Bluff Site (41WM165) and site 41WM21 (Shafer, et al. 1978). The typical projectile points (Bulverde and Travis types) of this phase for Central Texas are not predominant in the Granger Reservoir. Rather, Dawson points and previously undefined Groups 1, 2, 4, and 7 are best represented. A single date of 4280 ± 240 B.P. (Rl-1087) from Feature 9 at the Cervenka Site indicates that these diagnostic artifacts were dominant after 5000 B.P.

A total of 13 tools from site 41WM124 and 415 from site 41WM267, excluding projectile points, were collected during excavation of the Clear Fork components in the Granger Reservoir. Debitage and tool densities are much higher than during the preceding San Geronimo component.

As was true during the previous time period at site 41WM267, retouched pieces are more numerous than biface fragments, although the actual numbers are now much closer (36% versus 34%). In the 41WM124 assemblage, biface fragments are much more frequent than the retouched pieces, but the smallness of the sample drastically reduces its influence on the general Granger Reservoir profile (Table 17.3-1).

When excluding the above two tool classes (70% of the tool kit) the notched pieces are most numerous (restricted % = 24); they are mostly single notched flakes, but there are several multiple notched pieces. Denticulates follow and are mainly simple denticulated flakes, but nearly one third are serrated pieces, an unusually high amount. Complete bifaces and preforms are much more important than in the San Geronimo component (restricted % = 19). They occur in wide variety, and several are stemmed and notched bifaces, some of which are unique specimens. Burins (restricted % = 9), now slightly less important, still are mostly single angle burins, but double burins also were observed. Scrapers and truncations occur in equal numbers (restricted % = 7). The truncations are predominantly distal and dorsal. Most scrapers are single end or sidescrapers. The boring tools are exclusively gravers and borers (restricted % = 5 each). Most gravers were made on the flake edge, while for the borers there is no preference: they are on axis, on flake edge or oblique in equal numbers. The backed pieces (restricted % = 5) are mostly backed on one edge only, sometimes partially. The axes, which were fairly important during the San Geronimo Phase, are now completely absent. Instead, there are gouges. Chopping tools are still present.

Cores are much less abundant than in the San Geronimo component, but the internal frequency of the core types does not change significantly. Only wedge cores no longer occur in the Clear Fork component.

Occupational intensity was quite high at the Cervenka Site during this phase. High densities of lithic and faunal remains are associated with informal clusters of burned rock or small basin-shaped hearths. Dump areas, represented by massive accumulations of faunal debris, are also present. The larger basin-shaped hearths of the San Geronimo component are notably absent in the area sampled at the Cervenka Site.

A diffuse foraging subsistence strategy is indicated by the wide variety of species exploited from both the bottomland and upland prairie environments. Cottontail rabbit, deer, turtle, fish, and molluscs were obtained from the bottomlands while jackrabbit, pronghorn antelope, ground squirrel, and prairie chicken were procured

TABLE 17.3-1: Totals, percentages and restricted percentages for the tools from the Clear Fork Phase in the Granger Reservoir.

	Site 41WM124			Site 41WM267			Granger Res.		
TOOL CLASSES	#	%	Restr.%	#	%	Restr.%	#	%	Restr.%
Scrapers	1	7.69	16.67	8	1.93	6.50	9	2.10	6.98
Denticulates				19	4.58	15.45	19	4.44	14.72
Notched p.	2	15.38	33.33	29	6.99	23.58	31	7.24	24.02
Gravers				7	1.69	5.69	7	1.64	5.43
Borers	1	7.69	16.67	6	1.45	4.88	7	1.64	5.43
Truncations				9	2.17	7.32	9	2.10	6.98
Backed p.				7	1.69	5.69	7	1.64	5.43
Burins				11	2.65	8.94	11	2.57	8.52
Retouched p.	2	15.38	-	150	36.13	-	152	35.50	-
Bifaces	2	15.38	33.33	23	5.55	18.70	25	5.85	19.38
Biface frags.	5	38.48	-	142	34.21	-	147	34.35	-
Gouges				1	.24	.81	1	.23	.78
Chopping Tool				2	.48	1.63	2	.47	1.55
Scaled/battered				1	.24	.81	1	.23	.78
TOTAL	13	100.00	100.00	415	100.00	100.00	428	100.00	100.00
Restr. TOTAL	6			123			129		

on the uplands. Although preservation of floral remains is not good at the Cervenka Site, the presence of one charred sunflower seed from the Clear Fork component indicates part of the local flora utilized by the inhabitants. The lack of ground stone (Table 14.6-1), however may indicate that floral resources were either not particularly important or that the ones used did not require ground stone tools for processing.

17.4 Round Rock Phase

Very few components of the Round Rock Phase have been discovered in the Granger Reservoir. Whether this lack is due to the stratigraphic position of these components well below the modern surface of the floodplain or to an actual low level of occupational activity during this time period (4000 - 2600 B.P.) is unclear. Given the present data base, components of this period may be overlooked, for assignment of this phase relies totally on the presence or absence of Pedernales type projectile points. Although a limited number of Pedernales points have been recovered from the Bryan Fox Site, Loeve-Fox, Cervenka, site 41WM135, site 41WM163, site 41WM122, site 41WM133, and site 41WM21, other diagnostic artifacts may be more common for the Blackland Prairie area. The overwhelming dominance of the Pedernales point on the Edwards Plateau may not extend onto the Coastal Plain.

Most of the above occurrences of Pedernales points have been isolated finds near the bottoms of backhoe trenches at sites where only limited testing has occurred. The Loeve-Fox Site is the only site where a Round Rock component has been investigated to any degree. Even there the areal extent of the investigations is quite limited. Pedernales points were recovered from the excavation units at the Cervenka Site, although they were recovered in contexts dominated by diagnostics of the Clear Fork or San Marcos Phases. The lack of radiocarbon dates from these contexts precludes any conclusions regarding the apparent lack of a Round Rock component at the Cervenka Site. Either this site, which had been occupied intermittently for thousands of years, was not occupied during the Round Rock Phase or Pedernales points were not an important part of the assemblage. The presence of Pedernales points in the Loeve-Fox assemblage and the numerous other isolated finds indicates that the former may be more likely.

The tool sample from this phase is quite small (Table 17.4-1). The Loeve-Fox Site (41WM230) yielded 39 tools (points excluded) while 41WM163 yielded only six (points excluded). The volume of matrix removed had a significant effect on these figures. Nevertheless, debitage and tool densities within the matrix sampled are quite low.

Biface fragments are the most numerous single tool class (38% of the tool assemblage), followed by retouched pieces (16%). The latter are exclusively unilaterally retouched pieces at site 41WM163, mostly bilateral at site 41WM230. When excluding the above two tool classes,

TABLE 17.4-1: Totals, percentage and restricted percentage for the tools from the Round Rock Phase in the Granger Reservoir.

	Site 41WM163			Site 41WM230			Granger Reservoir		
TOOL CLASSES	#	%	Restr.%	#	%	Restr.%	#	%	Restr.%
Scrapers				1	2.56	5.56	1	2.22	4.76
Denticulates				1	2.56	5.56	1	2.22	4.76
Notched p.	1	16.67	33.33	1	2.56	5.56	2	4.44	9.52
Picks				1	2.56	5.56	1	2.22	4.76
Truncations	1	16.67	33.33	2	5.13	11.11	3	6.67	14.29
Backed p.				2	5.13	11.11	2	4.44	9.52
Burins	1	16.67	33.33	4	10.26	22.22	5	11.11	23.81
Retouched p.	2	33.32	-	5	12.82	-	7	15.56	-
Bifaces				6	15.39	33.33	6	13.33	28.58
Biface frags.	1	16.67	-	16	41.03	-	17	37.79	-
TOTAL	6	100.00	99.99	39	100.00	100.01	45	100.00	100.00
Restr. TOTAL	3			18			21		

burins (restricted % = 24) form the largest tool class consisting of two subtypes. Most burins are single angle burins on snap; the others are dihedral burins. Complete bifaces and preforms are well represented and they all come from site 41WM230. Truncations (restricted % = 14) are all single distal dorsal truncations on flakes. Notched and backed pieces occur in equally low numbers (restricted % = 10 each). The notched pieces are all single notches on flakes, the backed pieces are only partially backed by dorsal retouch. Scrapers, denticulates and boring tools (one pick) are very scarce.

Cores are extremely few from the Round Rock components in the Granger Reservoir; only nine were found. There is no preference for any particular core type, because single platform, double platform and multiple platform cores occur in equal numbers. Other core types were absent.

The few features from this phase occur mostly at the Loeve-Fox Site. Basin hearths and burned clay/charcoal pits, often in close association, are characteristic (Appendix J). Scattered burned rocks are also present. A more dense lens of burned rock which was uncovered in a test pit at site 41WM122 is tentatively assigned to this same period.

Occupational intensity appears to be very low in the Granger Reservoir area during this phase. The Loeve-Fox Site component indicates a limited foraging subsistence strategy by small groups of people (Appendix J). The limited appearance of Round Rock components elsewhere, if representative of the actual situation, indicates that the Granger Reservoir area was not a desired environment for hunter-gatherers during this period. The gastropods from the Loeve-Fox site (Chapter 15.6) denote an open grassy environment until the end of the San Marcos Phase. Elsewhere at the Cervenka Site and the Adamek Site (41WM135), an open and drier environment is indicated until during the San Marcos Phase. It may be that the carrying capacity of the Granger Reservoir was not sufficient to support a large population of hunter-gatherers during the Round Rock Phase.

17.5 San Marcos Phase

Components of the San Marcos phase are best represented at the Cervenka Site (41WM267), the Bryan Fox Site (41WM124), and the Loeve-Fox Site (41WM230). Limited testing also demonstrated that San Marcos components are present at sites 41WM163, 41WM126, and 41WM135, the Adamek Site (Eddy 1973). Recognition of this phase relies heavily on the presence of diagnostic projectile point types: Montell, Marcos, Castroville, Marshall, and Williams. Only two of these components, that of the Cervenka Site and the Bryan Fox Site, have yielded sufficient charcoal samples for radiocarbon dates. A single date of 1700 $\pm$ 120 B.P. (RL-1586) was obtained from a hearth in the upper portion of the San Marcos component at the Cervenka Site. The transition from the

San Marcos to the Twin Sisters Phase is dated at 1745 ± 85 B.P. (UGa-2476) at the Bryan Fox Site. Both a Fairland/Ensor point and a Montell point were associated with this sample from a basin-shaped hearth. The levels above the hearth contained diagnostic artifacts of the Twin Sisters Phase ; the levels below continaed elements of the San Marcos Phase only. Elsewhere in Central Texas the above diagnostic artifacts are found in contexts dating between 2600 and 1750 B.P. (Prewitt 1976).

A total of 67 lithic tools from site 41WM124, 10 from site 41WM163, 42 from site 41WM230 and 231 from site 41WM267, excluding projectile points, were collected from the San Marcos component in the Granger Reservoir. Debitage and tool densities are low to intermediate, the former especially true at sites 41WM230 and 41WM124 (Table 17.5-1).

As has been true for the Granger Reservoir samples in earlier cultural components, retouched pieces are more numerous than biface fragments, and this is not exclusively because of the dominant 41WM267 sample. The retouched pieces are more abundant than the biface fragments at site 41WM230, of equal value at site 41WM163, and only slightly less numerous at site 41WM124. At all of the sites they are predominantly unilaterally retouched pieces. Biface fragments make up 28% of the tool sample, retouched pieces 36%. When one excludes the above two tool classes, notched pieces are the most important class (restricted % = 21). They are one of the few tool types that appeared at all of the sites. Most of these tools are single notched flakes, several with continuous additional retouch. There are few multiple notched pieces, and there is no consistency in the occurrence of the miscellaneous subtypes. Next are the scrapers (restricted % = 17), the majority of which are single endscrapers, several with additional continuous retouch. Sidescrapers are rare, as are all of the other scraper types. Boring tools are rather well represented (restricted % = 12), mostly by gravers (restricted % = 7). The majority of these were made on the flake axis. Borers and drills are also present, as is one pick. Denticulates and burins occur in equal numbers (restricted % = 11). The former are almost exclusively simple denticulated flakes, although one serrated piece was found in this context. Burins occur in wide variety, each subtype represented by one or a few tools only. Single angle burins on snap are predominant, although a single angle burin on truncation was found. All the complete bifaces (restricted % = 4) are small triangular to sub-triangular tools. All the complete preforms (restricted % = 5) came from site 41WM267, and equally represent the three subtypes. The backed pieces (restricted % = 8) also comprised a wide variety of subtypes, without a preference for any specific subtype. Truncations are rather scarce (restricted % = 5), and all are single distal truncations, half made by dorsal, half by ventral retouch. Chopping tools are rather well represented (restricted % = 4), axes are few (restricted % = 2), while one composite tool and one unifacial were found. No other tool classes were represented in this component.

TABLE 17.5-1: Totals, percentage, and restricted percentage for tools from the San Marcos Phase in the Granger Reservoir.

	Site 41WM124			Site 41WM163			Site 41WM230			Site 41WM267			Granger Reservoir		
Tool Classes	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %
Scrapers	6	8.96	22.23				3	7.14	16.67	12	5.19	15.19	21	6.00	16.67
Denticulates	2	2.99	7.41				1	2.38	5.56	11	4.76	13.92	14	4.00	11.11
Notches	8	11.94	29.64	1	10.00	50.00	1	2.38	5.56	16	6.93	20.25	26	7.43	20.64
Gravers	2	2.00	7.41				2	4.76	11.11	5	2.16	6.33	9	2.57	7.14
Borers	1	1.49	3.70							1	.43	1.27	2	.57	1.59
Drills										3	1.30	3.80	3	.86	2.38
Picks	1	1.49	3.70										1	.29	.79
Truncations				1	10.00	50.00				5	2.16	6.33	6	1.71	4.76
Backed Pieces	4	5.97	14.81				3	7.14	16.67	3	1.30	3.80	10	2.86	7.94
Burins	1	1.49	3.70				4	9.52	22.21	9	3.90	11.39	14	4.00	11.11
Composite T.										1	.43	1.27	1	.29	.79
Retouched P.	19	28.36	-	4	40.00		19	45.25	-	85	36.80	-	127	36.28	-
Bifaces	1	1.49	3.70				2	4.76	11.11	8	3.47	10.12	11	3.14	8.73
Biface Frags.	21	31.34	-	4	40.00		5	11.91	-	67	29.00	-	97	27.71	-
Axes										2	.87	2.53	2	.57	1.59
Chopping T.	1	1.49	3.70				2	4.76	11.11	2	.87	2.53	5	1.43	3.97
Unifaces										1	.43	1.27	1	.29	.79
TOTAL	67	100.00	100.00	10	100.00	100.00	42	100.00	100.00	231	100.00	100.00	350	100.00	100.00
Restricted Total	27			2			18			79			126		

A total of 36 cores were collected in the San Marcos components of the Granger Reservoir, mostly from site 41WM267 (22 or 61%). Single platform and double platform cores occur in equal quantities. In the double platform class, all subtypes are equally well represented. Multiple platform cores are also frequent, but only one subdiscoidal core was found.

Features of this component are primarily either basin-shaped hearths or flat, informal clusters of burned rock. Both types of hearths occur at each site. At the Bryan Fox Site, massive lenses of burned rock were also accumulating during this period. Whether the massive mound of burned rocks (which had been severely disturbed by collectors prior to the NTSU investigations), accumulated solely during this period is unclear. Nevertheless, it is apparent that the processes contributing to this accumulation are very similar to those contributing to the burned rock middens of the North Fork Reservoir. Other burned rock accumulations have been noted in the Granger Reservoir area, but none has been investigated. If these accumulations represent the specialized utilization of a particular food resource, then that resource which was abundant on the Edwards Plateau also may have been locally abundant at the Bryan Fox Site. Alternatively, it may be hypothesized that the accumulation at the Bryan Fox site is merely the result of intensive utilization of the site locale as a living area. The continued use of heated limestone cobbles in the cooking and/or heating features on a relatively stable land surface, such as the terrace surface at the Bryan Fox Site, could have produced such an accumulation. Unfortunately, the available data base does not allow any conclusions concerning the viability of either hypothesis.

Of particular significance for this time period is the presence of a cremation associated with strata of the San Marcos component of the Loeve-Fox site. This cremation is the earliest example of interment practices within the San Gabriel River valley. The earliest evidence of contact with areas beyond the San Gabriel River valley is also provided by this interment. The presence of a conch columella bead with the cremation together with a Marginella shell found elsewhere in the San Marcos component provides evidence of either direct contact with the coast or indirect trade. Although either is possible, the latter seems more likely.

Other than the massive accumulation of burned rock at the Bryan Fox Site, there is little indication that any of the sites were intensively utilized for any length of time during the San Marcos Phase. Sites were repeatedly visited during this period, but the densities of cultural debris indicate that the occupations were ephemeral.

A variety of resources -- woodland (deer, rabbit), prairie (bison, pronghorn, prairie chicken), and aquatic (turtle, fish, waterfowl) were exploited. Although smaller mammals are predominant in most assemblages, inter-site variability is notable. The Adamek Site

assemblage reveals no utilization of prairie resources, but a heavy reliance on small mammals and aquatic resources from backwater sloughs is indicated (Eddy 1973: 287-300). At the Cervenka Site, the utilization of sloughs is evident, but a variety of prairie resources also is present. Herds of bison and pronghorn antelope, however, were not the primary targets of these people's subsistence strategies. Quail and prairie chicken were most commonly procured. Bison remains, although present in most of the sites of this period, did not represent a consistent food source for these people.

Floral remains also are significant among the components of this phase. Acorns are found only at the Bryan Fox Site. A limited amount of grass and hackberry seeds also are present. Elsewhere at the Loeve-Fox and Cervenka Sites, grasses and Cheno-am are only minimally represented (Chapter 15.2). Hackberry seeds and unidentified grass seeds were recovered from the Adamek Site (Eddy 1973: 278-279). The relatively low representations of seeds together with the almost complete absence of ground stone tools in this component (Chapter 14.6 Table 14-3) suggests that floral resources were either not utilized extensively or not abundant enough to be worthwhile. Whatever the reasons, the general impression from the food resources utilized and the ephemeral nature of the occupations is that the overall carrying capacity of the Granger Reservoir area may have been relatively low during the San Marcos Phase.

17.6 Twin Sisters Phase

A Twin Sisters component is present at several of the sites recently investigated in the Granger Reservoir. The Bryan Fox Site (41WM124), Bigon-Kubala (41WM258), Loeve-Fox (41WM230), Cervenka (41WM267), site 41WM163, and site 41WM126 each contain significant cultural deposits of this period. Previously investigated sites such as Dobias-Vitek (41WM118), the Adamek Site (41WM135), and the Hoxie Bridge Site (41WM130) also have revealed Twin Sisters components (Eddy 1973; Bond 1978). Unlike many of the other components represented in sites along the San Gabriel River, this component is well dated by 13 radiocarbon dates from the above sites (Chapter 7.1, Table 7.1-1). The Twin Sisters occupation at the Loeve-Fox Site, documented by 9 radiocarbon dates, spans a period of 500 years from approximately 1750 to 1250 B.P. A single date of 1745 ± 85 B.P. (UGa-2476) from the Bryan Fox Site dates the appearance of Twin Sisters elements (Fairland/Ensor point types) at that site. The Hoxie Bridge Site was apparently occupied at the same time as a date of 1740 ± 100 (Tx-2731) was obtained from a hearth associated with Darl points (Bond 1978:122). Occupation of these sites apparently continued for some time. The only reliable date (other than those from Loeve-Fox) for a later occupation during this phase, however, is that of 1350 ± 70 B.P. (Tx-804) from the Dobias-Vitek Site (Eddy 1973:34-36). Darl points are again in association. Four sherds of sandy paste pottery were recovered from the level above the hearth which was dated.

Similar sherds also have been recovered from the Hoxie Bridge Site, although direct association with Twin Sisters component material is lacking (Bond 1978:137-138). Nevertheless, a relatively early date for the appearance of the sandy paste pottery is apparent for the boundary area between Central and East Texas (Tunnell 1961; Ambler 1967; Shafer 1974). The very limited occurrence of these sherds in only two Granger Reservoir sites, however, indicates that ceramic vessels were not an integral part of the technology during the Twin Sisters Phase.

A total of 78 lithic tools from site 41WM124, 36 from site 41WM163, 197 from site 41WM230, ten from site 258 and 59 from 41WM267 (Table 17.6-1), excluding projectile points, were collected from the Twin Sisters components in the Granger Reservoir. The debitage and tool densities are generally low to medium, with the highest density at site 41WM124.

Most of the samples for this component are rather small. For the sites where there is no sample size problem, there are some differences. As usual, biface fragments and retouched pieces form more than half of the tool assemblage. When the entire reservoir is under consideration as a unit, biface fragments (37%) form the largest tool class, with the retouched pieces second most important (27%). At the same time, it needs to be noted that a reversed order in frequency was encountered at sites 41WM163 and 41WM267 where in both cases the retouched pieces are more numerous than the biface fragments. In all sites, the retouched pieces are predominantly unilaterally retouched. When excluding the above two tool classes, notched pieces and complete bifaces and preforms occurred in equal numbers (restricted % = 15 each). The relatively high occurrence of complete bifaces and preforms is mainly due to large numbers of these artifacts at site 41WM230 especially, but also at site 41WM267. For the latter site, preforms are dominant. Where such information is available (not for site 41WM230), the complete bifaces are small, triangular to subtriangular tools. The vast majority of the notched pieces are single notches on flakes; only one was made on a blade. Very few tools displayed any additional continuous retouch. No multiple notched pieces were recovered. Backed pieces (restricted % = 13) also are numerous, especially at site 41WM230. In most cases, the tool is backed along an entire edge, but a few partially backed pieces do occur. There seems to be a preference for a nearly straight backed edge.

In the total Granger Reservoir assemblage, scrapers and denticulated pieces occur in equal numbers (restricted % = 8 each), but at sites 41WM230 and 41WM267 denticulates are more numerous than scrapers, while scrapers are predominant at site 41WM124. Both classes occur in equal numbers at site 41WM163, but are absent at site 41WM258. A large variety of scraper subtypes are present, with no marked preference for any special subtype, although two very rare micro-scrapers are present. The denticulated pieces are mostly simple denticulated flakes, only one made on a blade. There are a few serrated pieces, two of which are partially serrated flakes from site 41WM230. Boring tools do occur with moderate frequency (restricted %=8)

TABLE 17.6-1: Totals, percentage, and restricted percentage for the tools from the Twin Sisters Phase in the Granger Reservoir.

Tool Classes	Site 41WM124			Site 41WM163			Site 41WM258			Site 41WM230			Site 41WM267			Granger Reservoir		
	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %
Scrapers	5	6.41	16.13	1	2.78	11.11				4	2.03	5.41	1	1.69	5.00	11	2.89	8.09
Denticulates	3	3.85	9.68	1	2.78	11.11				5	2.54	6.76	2	3.39	10.00	11	2.89	8.09
Notches	5	6.41	16.13	1	2.78	11.11				10	5.08	13.51	5	8.47	25.00	21	5.53	15.44
Gravers	3	3.85	9.68	1	2.78	11.11				3	1.52	4.05	2	3.39	10.00	9	2.37	6.62
Borers	1	1.28	3.23													1	.27	.74
Picks										1	.51	1.35				1	.27	.74
Truncations	3	3.85	9.68	1	2.78	11.11				3	1.52	4.05				7	1.84	5.15
Backed Pieces	2	2.56	6.45	3	8.33	33.33				11	5.58	14.86	1	1.69	5.00	17	4.48	12.50
Burins	3	3.85	9.68							5	2.54	6.76	1	1.69	5.00	9	2.37	6.62
Retouched P.	15	19.23	-	14	38.88	-	2	20.00	-	50	25.39	-	23	38.99	-	104	27.37	-
Bifaces	4	5.12	12.89				1	10.00	50.00	28	14.21	37.85	8	13.57	40.00	42	11.06	30.86
Biface Frags.	32	41.03	-	1	2.78	11.11				73	37.06	-	16	27.12	-	140	36.84	-
Chopping T.	2	2.56	6.45	13	36.11	-	6	60.00	-	3	1.52	4.05				6	1.58	4.41
Unifacials							1	10.00	50.00	1	.51	1.35				1	.27	.74
TOTAL	78	100.00	100.00	36	100.00	99.99	10	100.00	100.00	197	100.00	100.00	59	100.00	100.00	380	100.00	100.00
Restricted Total	31			9			2			74			20			136		

and are almost exclusively gravers. Only one borer and one pick were found. Most of the gravers were made on the flake edge, but most of the other subtypes also occur. Burins are rather scarce (restricted % = 7) and entirely absent at site 41WM163. They are predominantly single angle burins, but one double angle and one transversal burin were encountered. Truncations (restricted % = 5) were not found at site 41WM267 in this cultural component. At the other sites they are mainly single distal truncations, made mostly by dorsal retouch. Quite a number of chopping tools (restricted % = 4.5) were found at this time period; half of these come from site 41WM230. The only other tool class represented are unifacials.

Many cores were found at site 41WM230 in a Twin Sisters component context (46 or 82%). A total of 58 cores were found in all of the Granger Reservoir sites, but none were excavated at site 41WM258. The majority of the cores have single platforms (24 or 41%), 16 (or 28%) have double platforms. Most of the latter are at a 90° degree angle to each other. There are 17 (or 29%) multiple platform cores, and one wedge core.

Basin-shaped hearths or ovens are the characteristic features of this phase. These hearths are often rock lined and exhibit lenses of heat altered soil around their perimeters. Informal clusters of burned rock and charcoal also are present. At the Loeve-Fox Site, features designated as burned clay/charcoal pits and arcuate hearths have been reported (Appendix J). The basin-shaped hearths at the Loeve-Fox Site contain considerable variability. Many of the smaller basins may have served as warming, rather than cooking, loci. Cooking and/or heating is assumed to be the function of all of these features. The larger basin-shaped hearths would have served well as ovens for the preparation of either meat or vegetable resources.

As with the other components of these sites, diversity of feature types is very low. Other than the cooking and/or heating features, only a single storage pit from the Dobias-Vitek Site has been recognized (Eddy 1973:71-72). Either storage for lean periods was not necessary or means of storage other than dug pits were utilized.

Site location is quite varied in the Granger Reservoir. Natural levee formations and other riparian situations were preferred. Both the mainstream of the San Gabriel River and its tributaries were utilized during this period. Terrace situations well back from the channel also were utilized.

Although all of the sites were located in close proximity to the upland prairie areas, exploitation of prairie resources was quite limited. Bison, pronghorn antelope, jackrabbit, and prairie chicken are only minimally represented (Chapter 15.7). Woodland and aquatic resources were intensively utilized with deer, rabbit, turkey, fish, and several reptilian species all represented during this period.

The floral resources also indicate a heavy dependence on the wooded bottomlands. Acorns, pecans, and hackberry seeds are present (Chapter 15.2), but not in large quantities. The presence of several varieties of grasses and Canadian wild rye indicate utilization of the understory vegetation in the bottomlands. Other than at the Bryan Fox and Loeve-Fox Sites, however, ground stone tools which would have been used to grind these resources are very poorly represented. Wooden mortars may have been used, but it is equally likely that the floral resources utilized could be processed without grinding. Nonetheless, it is apparent that either the surrounding prairie zone was rather unproductive at this point in time or that the woodland and riparian environments were suficiently productive so there was no need to venture any distance onto the prairie for subsistence resources.

17.7 Austin Phase

Stratigraphically discrete components of the Austin Phase are limited within the Granger Reservoir area. Most often diagnostic artifacts of the Toyah and Austin Phases are intermixed. Nevertheless, relatively discrete Austin components can be recognized at the Loeve-Fox Site, Bigon-Kubala, Hoxie Bridge (Bond 1978), and the Dobias-Vitek Site (Eddy 1973). Mixed assemblages of the Austin and Toyah Phases are also found at the Bryan Fox Site, 41WM163, and the Loeve Site.

Nine reliable radiocarbon dates have been obtained for this phase. Six of these (Table 7.1-1) place the Austin Phase occupations between 1250 and 850 B.P. at the Loeve-Fox Site. Portions of the Austin component at the Hoxie Bridge Site (Bond 1978) yielded dates of 700 ± 60 B.P. (Tx-2730) and 800 ± 70 B.P. (Tx-2729). Apparently, the Dobias-Vitek Site (41WM118) was occupied at the same time for a date of 770 ± 70 B.P. (Tx-806) was obtained from a hearth with Scallorn and Perdiz type points in stratigraphic association (Eddy 1973:35).

A total of 15 lithic tools from site 41WM163, 14 from site 41WM230 and two from site 41WM258 (Table 17.7-1) were recovered from Austin component contexts in the Granger Reservoir. The totals above do not include the projectile points. Frequency of tools and debitage as well as densities, dropped significantly since the Twin Sister Phase, and most tool classes are only represented by one or a few artifacts.

As has been the case previously in the Granger Reservoir, the retouched pieces form the single most important tool class within this component (39% of the total tool assemblage). Biface fragments are less numerous (19%). The unilaterally retouched pieces are dominant, but bilaterally retouched pieces are almost as frequent. When the above two tool classes are excluded, single notched flakes are the most frequent tools (restricted % = 23). Truncations and backed pieces occur in equal numbers (restricted % = 15 each) as do complete bifaces. No complete preforms were found. The truncations were made by dorsal retouch only, either proximal or distal. All the bifaces are small

TABLE 17.7-1: Totals, percentage, and restricted percentage for the tools from the Austin Phase in the Granger Reservoir.

	Site 41WM163			Site 41WM230			Site 41WM258			Granger Reservoir		
Tool Classes	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %	#	%	Restr. %
Denticulates				1	7.14	14.29				1	3.23	7.69
Notches	2	13.33	40.00	1	7.14	14.29				3	9.68	23.10
Truncations	2	13.33	40.00							2	6.45	15.38
Backed Pieces				2	14.29	28.55				2	6.45	15.38
Burins				1	7.14	14.29				1	3.23	7.69
Retouched P.	7	46.67	-	5	35.72	-				12	38.70	-
Bifaces				1	7.14	14.29	1	50.00	100.00	2	6.45	15.38
Biface Frags.	3	20.00	-	2	14.29	-	1	50.00	-	6	19.35	-
Unifaces				1	7.14	14.29				1	3.23	7.69
Scaled/Batt.	1	6.67	20.00							1	3.23	7.69
TOTAL	15	100.00	100.00	14	100.00	100.00	2	100.00	100.00	31	100.00	100.00
Restricted Total	5			7			1			13		

triangular to subtriangular artifacts. Denticulates, burins, unifaces, and scaled and battered pieces were all represented by one artifact only.

Eight cores were recovered in the Austin component of the Granger Reservoir; one came from site 41WM258, the other seven from site 41WM230. That is relatively a very high number for the latter site, especially when one considers the very low number of tools in this component. The cores are nearly all single platform cores, except for two multiple platform cores from site 41WM230.

Characteristic features of this phase are rock-lined, basin-shaped hearths. The soil surrounding these basins often is heat-altered. No specific function for these distinctive hearths or earth ovens has been determined since they could have been used to cook a variety of food resources. Burned clay/charcoal pits have been identified at the Loeve-Fox Site (Appendix J). A possible storage pit at the Dobias-Vitek Site may be associated with an Austin component (Eddy 1973:72).

Perhaps the most significant feature of this phase is the cemetery from the Loeve-Fox Site. Twenty-seven examples of non-cremated interments and ten examples of cremated interments have been recovered. The variety and number of grave goods associated with these interments suggest that status differentiation within the population was not emphasized (Appendix J). Nevertheless, the differential treatment of the burials (noncremated vs. cremated) may reflect social status differences rather than the circumstance of death as previously postulated (Appendix J).

The cause of death for some interments was human aggression as indicated by Scallorn points either embedded in vertebrae or situated in positions which were suggestive of such a conclusion. Apparently, conflict resolution sometimes involved acts of violence. The small proportion of individuals having evidence of human aggression as a cause of death (Appendix J, Exhibit 1) indicates that conflict may have been infrequent.

The density of faunal and floral remains is relatively low during this phase (Chap. 15.7, 15.2), but a wide variety of resources is present. Deer, although poorly represented, remain as the primary source of meat. Small animals, primarily rodents and reptiles, are especially numerous. Aquatic resources, such as frogs, fish, and beaver are represented. Prairie resources, other than prairie chicken and isolated fragments of bison, are very poorly represented in assemblages of this phase.

Floral resources, primarily from the Bigon-Kubala, Hoxie Bridge, and Loeve-Fox sites, are quite varied. Hickory, acorn, and pecan nuts denote the presence of a hardwood forest along both the San Gabriel River and Willis Creek. Hackberry seeds are common. Sunflowers and various bottomland grasses also were utilized by the occupants

of these sites. Since the densities of cultural debris are relatively low during this phase, the sites apparently served as ephemeral foraging camps for small bands. Although the presence of the cemetary at the Loeve-Fox site denotes that the site served a special function, there is no indication that the site served as a long term base camp.

17.8 Toyah Phase

Distinctive components of the Toyah Phase are present at the Bigon-Kubala Site and the Loeve-Fox site. Elsewhere at the Bryan Fox Site, Hoxie Bridge, Dobias-Vitek, Loeve, and site 41WM163, Toyah components are represented by the presence of Perdiz points and Leon Plain pottery; although diagnostic artifacts of the Austin Phase are often intermixed. Only one radiocarbon date was obtained from the distinctive components of this phase. A date of 430 ± 70 B.P. (UGa-2477) was obtained from a hearth associated with Perdiz points, Leon Plain pottery, and a scatter of bison bones at the Bigon-Kubala Site (41WM258). Elsewhere in Central Texas, occupations of this phase usually date between 400 and 650 B.P.

A total of eight lithic tools from site 41WM230 and seven from site 41WM258, excluding projectile points, were collected during excavations of the Toyah component in the Granger Reservoir. Tool and debitage densities are now even lower than in the Austin component.

Only biface fragments and retouched pieces were discovered in Toyah context at site 41WM230. Overall, biface fragments dominate (52% of tool kit) followed by the retouched pieces (32%). Unilaterally retouched pieces are more numerous than bilaterally retouched pieces. Four other tool classes are represented by one single artifact: denticulated pieces, borers, complete bifaces and axes. Three cores were associated with the Toyah component; two are multiple platform cores, one is a double platform core (Table 17.8-1).

The formal structure of features of this phase varies significantly between sites. At the Bigon-Kubala Site, a small cluster of burned *Exogyra* shells comprise the only hearth attributed to occupants of this phase. A larger informal cluster of burned rocks is present within the Toyah component of the Loeve-Fox Site (Appendix J). Elsewhere at the Hoxie Bridge Site (Bond 1978:124-136) the rock-lined, basin-shaped hearths apparently continued to be used during the Toyah Phase.

The utilization of faunal resources during this phase remains much the same as the preceding Austin Phase. Deer and small animals, primarily rodents and reptiles, are represented. Contrary to the preceding phase is the increased presence of prairie fauna in the form of bison, prairie chicken, and ground squirrel. The relatively low frequencies of even these species indicate, however, that occupational intensity had not changed significantly. Apparently, a wider variety of resources was needed to support the occupants of this period.

TABLE 17.8-1: Totals, percentage, and restricted percentage for the tools from the Toyah Phase, in the Granger Reservoir.

	Site 41WM230			Site 41WM258			Granger Reservoir		
Tool Classes	#	%	Restr. %	#	%	Restr. %	Total	%	Restr. %
Denticulates				1	5.88	25.00	1	4.00	25.00
Borers				1	5.88	25.00	1	4.00	25.00
Retouched P.	4	50.00	-	4	23.53	-	8	32.00	-
Bifaces				1	5.88	25.00	1	4.00	25.00
Biface Frags.	4	50.00	-	9	52.95	-	13	52.00	-
Axes				1	5.88	25.00	1	4.00	25.00
TOTAL	8	100.00		17	100.00	100.00	25	100.00	100.00
Restricted Total	0			4			4		

17.9 Summary

Chronology

The most recent archaeological investigations at Granger Reservoir yielded seventeen additional radiocarbon dates (Table 6.1.-1;Appendix I). Although most of these dates pertain to the Twin Sisters Phase or later, dates critical to the delineation of the San Geronimo and San Marcos Phases were obtained. Since most of the available dates are from a limited number of sites, the relative stratigraphic positions of diagnostic projectile point types remain as the basis of the chronological scheme for many sites (Table 17.9-1).

The prehistoric occupation of the Granger Reservoir extends from before 8500 B.P. to approximately 150 B.P. The radiocarbon dates associated with the Granger assemblages do much to substantiate the proposed chronological scheme for Central Texas, especially the largely conjectural time frame for the Early Archaic (Weir 1976; Prewitt 1976; Patterson 1977). Some significant differences in the diagnostic projectile point types of the Granger assemblages are notable, however. Such differences may reflect the position of the Granger Reservoir area between the East Texas and Central Texas cultural areas or merely relate to an adaptation to the Blackland prairie region.

Fortunately, the most notable differences between the data of the Granger assemblages and the presently recognized chronological scheme (Patterson 1977) are accompanied by radiocarbon dates (Table 17.9-1). Three radiocarbon dates provide a temporal framework for the shift in projectile point styles between the San Geronimo and Clear Fork Phases. Prior to 5000 B.P. Hoxie, Andice, "Tortugas", Uvalde, Wells, and previously undefined Groups 9, 10, 12, and 13 are the common projectile point styles. The newly recognized forms dominate the assemblage while the traditional index markers are only minimally represented. Following 5000 B.P. Dawson points and previously undefined Groups 1, 2, 4, and 7 are the predominant projectile points. The traditionally recognized index markers of the Clear Fork Phase (Bulverde, Travis) are poorly represented.

The following Round Rock and San Marcos Phases are not as well documented. The previously discussed questions concerning the recognition of Round Rock assemblages in the Granger Reservoir might be resolved if the appropriate radiocarbon dates were available. Unfortunately, only the later part of the San Marcos Phase is dated. A date of 1700 ± 120 B.P. (RL-1586) was obtained from the Cervenka Site, while a date of 1750 B.P. from the Bryan Fox Site marks the stratigraphic contact of sediments bearing projectile points of the San Marcos and Twin Sisters Phases, respectively.

Several radiocarbon dates (Table 7.1-1) from the Loeve-Fox Site, the Hoxie Bridge Site, and the Dobias-Vitek Site are available for the Twin Sisters Phase. A temporal span from 1750 to 1250 B.P. for the

Table 17.9-1

Years B.P.	Phase	Index Markers: Central Texas*	Index Markers: Granger
150-650	Toyah	Perdiz Cliffton	Perdiz Leon Plain pottery
650-1250	Austin	Scallorn	Scallorn
1250-1750	Twin Sisters	Darl Frio Ensor Fairland	Darl Ensor Fairland Fairland/Ensor
1750-2600	San Marcos	Marcos Montell Williams Castroville Marshall	Marcos Montell Williams Castroville Marshall
2600-4000	Round Rock	Marshall Pedernales Bulverde	Pedernales
4000-5000	Clear Fork	Bulverde Nolan Travis Wells "Tortugas"	Dawson Group 1,2,4,7** Bulverde Travis "Tortugas"
5000-7000	San Geronimo	Angostura Gower Uvalde Martindale Bell "Tortugas"	Hoxie Andice Groups 9,10,13** "Tortugas" Uvalde Wells Group 12**
7000-8500	Circleville	Angostura Meserve Golondrina Scottsbluff	Angostura Meserve Golondrina

* (Patterson 1977)
** (Chapter 14.1)

Granger Reservoir area is well documented. Of the traditional diagnostic projectile points of this phase, only the Darl point appears with any frequency. Fairland and Ensor point types are poorly represented.

As noted earlier, the Austin Phase is equally well documented at these same three sites. Scallorn points are predominant at least between 1250 and 650 B.P. The appearance of the Perdiz point and Leon Plain pottery, which are diagnostic of the following Toyah Phase, is not so well documented. A single date of 480 $\pm$ 70 B.P. (UGa-2477) from the Bigon-Kubala Site is all that is available. However, it is known that groups of hunter-gatherers occupied the San Gabriel River valley at the time of the Sapnish intrusion into Central Texas around 250 B.P. (Bolton 1962; Castaneda 1936; Hackett 1931). Whether these people were related to the earlier occupants of the Granger Reservoir area is unknown.

Artifact Assemblage

The tool inventory of the occupants of the Granger Reservoir area displays little variability during 3,000 years of prehistory. Typologically, a very diverse tool kit is represented during all but the last two phases of occupation. This lack of diversity in the tool kit of the Post-Archaic period may reflect the less intense utilization of the area during that time. The Round Rock Phase assemblages also exhibit a limited range of tool classes. Whether this anomaly is related to the intensity of utilization or mere sampling bias remains to be determined.

Technologically, these assemblages also display remarkable conservatism through time. Examination of the lithic debitage from selected assemblages (Chapter 14.4) revealed that the reduction processes used to produce the tools remained much the same throughout the Archaic period. While this continuity also appears to extend into the Post-Archaic period, a more substantial data base from the final prehistoric assemblages is needed to verify such a continuity. The adaptive technology developed for the exploitation of the Granger Reservoir area was sufficiently generalized that changing environmental conditions and the resulting availability of resources did not require any major shifts in tool typology or production techniques.

Retouched pieces and biface fragments are the two most common tool classes of the Granger Reservoir assemblages. With only a few exceptions, the retouched pieces are usually more numerous. Such tools of expediency are well suited to a mobile adaptive strategy. The large number of biface fragments together with the large number of cores found in most of the assemblages of the Granger Reservoir sites indicates that much of the lithic reduction process occurred at the occupation sites rather than elsewhere at a quarry location (cf. Bond 1978).

The diversity of tools for most of the phases suggests that a diffuse foraging subsistence strategy was being employed. Notches, denticulates, complete bifaces and preforms, burins, scrapers, boring tools, chopping tools, axes, and gouges are represented in addition to the retouched pieces and biface fragments. Certain tool classes exhibit interesting temporal trends. Chopping toolsand axes are present only during the San Geronimo and San Marcos Phases. Whether these tools were used for woodworking or the splitting of bison long bones is unknown. Bison are present during these phases, although they are also utilized during the later phases of occupation. Unfortunately, the minimal representation of these tools in any of the assemblages lessens the significance of their absence elsewhere, for sampling bias is an important factor when the probability of thier presence is so small.

Interestingly, scrapers do not become an important part of the tool assemblage until the San Marcos Phase. After the San Marcos phase they follow only the retouched pieces, biface fragments, and notches in representation in the assemblages. Ground stone tools similarly do not become an integral part of the tool kit until the Twin Sisters, Austin, and Toyah Phases. Either wooden mortars and pestles had been used previously or prior environmental conditions were such that the prehistoric occupants could subsist on a more narrow range of food resources.

Sandy paste ceramics may appear for the first time during the Twin Sisters or Austin Phases (Eddy 1973; Bond 1978). Since these sherds are very limited in occurrence, they do not represent a significant change in the adaptive technology. Contact with ceramic using grounds to the southeast is likely, however. Although the sandy paste ceramics and Leon Plain ceramics occur with greater frequency during the later Toyah Phase, ceramic vessels never became a major portion of the artifact inventory. Apparently, storage was not a critical necessity, and the mobility of these people precluded the transportation of more than a few cooking vessels.

The only remaining change in the artifact inventory is the appearance of the bow and arrow around 1250 B.P. Alahtough the use of the bow was quickly adopted, the atlatl and spear continued to be utilized. If the adoption of the bow and arrow had a significant impact on the productivity of these people's subsistence efforts, it is not apparent from the San Gabriel data.

Settlement/Subsistence Patterns

Occupation of the Granger Reservoir area fluctuates significantly between 8500 and 150 B.P. During the Circleville and San Geronimo Phases occupational intensity, as indicated by the extremely low densities of lithic debitage and tools (Table 17.9-2), is very low.

Table 17.9-2
Tool and Debitage Densities of Components from
Sites of the Granger Reservoir

Components	Sites	Excavated Volume m^3	Tool Density N/m^3	Debitage Density N/m^3	Tool/ Debitage Ratio
San Geronimo	41WM267	25.05	9	315	1:35
Clear Fork	41WM124	1.1	13	1361	1:105
	41WM267	10.75	55	5720	1:104
Round Rock	41WM163	.6	13	1107	1:85
	41WM230	13.65	4	525	1:131
San Marcos	41WM124	4.9	20	896	1:45
	41WM163	.8	18	1208	1:67
	41WM230	4.75	11	756	1:69
	41WM267	12.55	23	2022	1:88
Twin Sisters	41WM124	4.0	24	2031	1:85
	41WM163	1.0	44	1944	1:44
	41WM258	1.4	12	376	1:31
	41WM267	7.9	8	816	1:102
	41WM230	25.0	10	1208	1:121
Austin	41WM163	.2	90	4670	1:52
	41WM230	8.1	3	190	1:63
	41WM258	1.4	4	445	1:111
Toyah	41WM230	9.1	2	37	1:19
	41WM258	5.1	5	207	1:41

The stratigraphic superpositioning of the features of these components indicates that the sites were reoccupied frequently. Other than the Tombstone Bluff Site (41WM165), the diversity of tools and faunal resources (aquatic, prairie, and woodland) reflects the function of the sites as generalized foraging camps. The Tombstone Bluff Site probably served as a hunting and lithic procurement camp (Appendix J).

This diffuse foraging subsistence strategy is maintained during the following Clear Fork Phase. In the few sites where components of this phase have been investigated, occupational inteysity is very high. Sites were apparently reoccupied frequently. High densities of lithic (Table 17-2) and faunal remains are associated with basin-shaped hearths and informal clusters of burned rock. A wide variety of aquatic, woodland, and prairie species are exploited during this phase. Floral resources are apparently not an important food source at this time, for groundstone tools are only minimally represented. Wooden mortars and pestles may have been used, however.

Site location during the Clear Fork Phase remains much the same as during the preceding phase. The most intensively utilized sites were situated at the juncture of the bottomlands and the upland slope. These sites situations permitted equal access to both the upland prairie and bottomland resources. Stream bank situations, possibly under-represented due to low archaeological visibility, were also utilized but with much less intensity. Both of these site situations functioned as generalized foraging camps. Upland sites like the Tombstone Bluff Site probably continued to serve as more specialized hunting and lithic procurement stations.

Data related to the Round Rock Phase occupations of the Granger Reservoir area are very limited. If it can be assumed that Pedernales projectile points are diagnostic of occupations of the Granger Reservoir area between 4000 and 2600 B.P., then occupational intensity was extremely low during the Round Rock Phase. Without associated radiocarbon dates the validity of the above assumption remains uncertain. Consequently, our understanding of this phase is very limited.

Based on the available data, occupations during the Round Rock Phase are ephemeral at all sites. Recurrence of occupation is much less frequent than in the preceding Clear Fork Phase. Sites are located either in the bottomlands or at the juncture of the bottomlands and the upland slope. A foraging subsistence strategy by small groups of people is postulated for this period.

During the following San Marcos Phase occupational intensity, as measured by lithic debitage and tool densities (Table 17.9-2), increases slightly and site differentiation in regard to resource utilization is notable. Deep basin-shaped hearths or ovens appear at the Bryan Fox Site during this phase. A massive accumulation of burned rock, similar to those of the Edwards Plateau region, also begins to form.

Such intensity of occupation is only paralleled by the utilization of the Cervenka Site. Informal clusters of burned rock, basin-shaped hearths, and associated artifacts represent recurrent, but ephemeral visits to the site.

Although a variety of resources (aquatic, woodland, and prairie) are secured during this phase, smaller mammals provide a major portion of the food supply. Some sites also reflect very limited exploitation of the prairie resources while others exhibit utilization of all available environments. Since all of the sites are similarly situated in relation to the available resource zones, seasonal variability in site occupation may be a contributing factor. As in the preceding phases, the local floral resources are not an important part of the subsistence strategy.

The earliest evidence for indirect trade and burial practices within the Granger Reservoir area is also encountered in a component of this phase. Cremation was apparently one means of interment used at that time. The presence of a conch columella bead with the cremation and a Marginella shell elsewhere in the assemblage indicate that an indirect trade route to the coast was functioning. Perhaps, the need to cover a larger territory for adequate food resources during this phase made contacts with other hunter-gatherer groups more frequent.

Intensity of occupation during the Twin Sisters Phase varies significantly among the several components (Table 17.9-2). Apparently, the prairie was not intensively exploited during this phase for the sites best situated for such utilization (Cervenka and Bigon-Kubala) exhibit the lowest densities of lithic debitage and tools. Both the faunal and floral resources also indicate an intensive exploitation of the wooded bottomlands. Natural levee formations and other riparian situations were the preferred locations for sites during this phase.

The settlement/subsistence patterns of the Twin Sisters Phase remain relatively unchanged during the subsequent Austin and Toyah Phases. The relatively low densities of cultural debris (Table 17.9-2) from these components indicate that the sites served as ephemeral foraging camps for small bands. Faunal and floral remains, although poorly represented in these components, reflect a continued utilization of the wooded bottomlands. Only during the Toyah Phase is there an increased reliance upon prairie fauna.

Intra-group or inter-group conflict was apparently resolved through acts of violence during the Austin Phase. The cemetery associated with this phase contains interments in which the cause of death was human aggression. Whether such aggression involved territorial disputes is largely conjectural for the nature of the conflict is very difficult to infer from the archaeological record.

However, given the low levels of occupation in the reservoir area, it seems unlikely that territorial disputes would be the cause of this aggression unless the local environmental conditions had deteriorated sufficiently to create a food shortage. Although there is no evidence to support such a scenario, it is apparent that the San Gabriel River valley was not a particularly attractive locale for hunter-gatherers of the Austin and Toyah Phases.

Paleoenvironment

As in the North Fork Reservoir, interpretations concerning the paleoenvironment necessarily rely on the data base provided by the vertebrate and invertebrate fauna and the macrobotanical remains. Although the fluctuations in these remains do not indicate that climatic changes were radical enough to dramatically alter the subsistence strategies, the relative moisture levels may have affected the intensity of the foraging economy throughout the 8500 years of occupation in the Granger Reservoir area. A reliable data base exists only for the period from approximately 6000 to 1250 B.P.

The gastropods from the San Geronimo and Clear Fork components of the Granger Reservoir reflect open and possibly drier site environments (Chapter 15.6). Species, such as A. stronglylodes and M. friabilis, which require a dense woodland cover are absent. However, the predominance of prairie species in the San Geronimo faunal assemblages and their importance in the Clear Fork assemblage suggest that the prairie environment was very productive. Therefore, moisture conditions were quite adequate. The overall carrying capacity of the area was apparently very good for the availability of resources drew people back to the Cervenka Site again and again during this time period.

Moisture levels appear to fluctuate downward during the following Round Rock and San Marcos Phases. The gastropods from the Loeve-Fox Site indicate an open grassy environment until the end of the San Marcos Phase (Chapter 15.6). Open and possibly drier environments are also present at the Cervenka and Adamek Sites until during the San Marcos Phase. At that point in time the arboreal canopy along Willis Creek is expanding (Eddy 1973:282) and a more moist woodland environment is established at the Cervenka Site. It is not surprising that the Cervenka Site was a favored location during this period. Although these data are hardly conclusive, the extremely low levels of occupational intensity during the Round Rock Phase and the less than intensive utilization during the San Marcos Phase indicate that the local environment may have been slowly recovering from a previously deteriorated condition during the Round Rock Phase.

Moisture levels were apparently adequate during the following Twin Sisters Phase. The available gastropod fauna (Chapter 15.6) from most of the sites denote heavily wooded site environments. Only the Dobias-Vitek Site and the Adamek Site contain gastropod fauna which reflect

an open canopy/grassy understory vegetation during this period (Eddy 1973:145-150, 267-268). Both the faunal and floral remains of this phase indicate an intensive exploitation of the wooded bottomlands.

Inferences concerning the climatic conditions of the Post-Archaic period of occupation are limited by the lack of pertinent data. Although a hardwood forest remains along both the San Gabriel River and Willis Creek, resource procurement apparently centers upon small mammals during the Austin Phase. Occupational intensity is also relatively low. During the Toyah Phase the decreased exploitation of aquatic resources suggests that relatively drier conditions may have prevailed. The limited tool assemblages of these phases indicate that occupations were quite ephemeral. Perhaps, the area was not particularly attractive to the occupants of Central Texas during this period.

It is not evident from the available data that the local environmental conditions had deteriorated significantly during the Post-Archaic period. Previous assessments of the Central Brazos River Basin (Skinner 1974:63; 1981) similarly postulate that a drying trend significantly affected settlement patterns and site densities during this period. More direct evidence related to actual climatic conditions is needed, however. Recent investigations in the proposed Richland Creek Reservoir in Navarro County provide some information. Initial analysis of pollen samples collected from the reservoir may suggest that drought conditions were present after 1000 B.P. (Raab, McGregor, and Bruseth 1981:553-578). If correct those data are especially pertinent to the Granger Reservoir situation, for the Richland Creek Reservoir is similarly located at the boundary of the Blackland Prairie and the oak-hickory forest to the south and east. Whether similar conditions prevailed in both locations remains to be determined. Only the analysis of further pollen and gastropod columns from good datable primary contexts will provide the data base for a regional perspective of the paleoenvironmental conditions.

18.0 Inter-Reservoir Comparison of Culture History

18.1 Circleville Phase

Chronology

Three sites were investigated in the North Fork and Granger Reservoir Districts which contained Circleville components. The Loeve Site (41WM133), located in the Granger Reservoir provides the only radiocarbon dates for this period. Three dates (Table 7 .1-1) obtained from hearths in sediments at the Loeve Site indicate a time span of 8500 to 7000 B.P. for this phase. However, Angostura, Meserve, and Golodrina projectile point styles were stratigraphically associated only with a 8500 B.P. date. Consequently, the actual time frame for this phase remains largely conjectural in Central Texas. These same projectile point types also were recovered from the Tombstone Bluff Site (41WM165), and Site 41WM419 which is located in the North Fork Reservoir.

Artifact Assemblages

Although samples of artifacts for this phase are limited, some comments can be made concerning the character of the assemblages. Assemblages from both reservoirs reveal a functionally diverse tool kit. Only the Tombstone Bluff Site (41WM165) exhibits a more specialized tool kit suited to hunting and lithic reduction (Appendix J). Lithic reduction was apparently an important activity at all of these sites for cores and hammerstones are well represented. However, only the North Fork Reservoir site contained the distinctive discoidal cores.

Settlement/Subsistence Patterns

In the Granger Reservoir there is an apparent functional differentiation between the riparian site situations and the upland situations. The meager evidence from the Tombstone Bluff Site suggests that it served as a specialized hunting/lithic procurement station. The Loeve Site, on the other hand, contained a variety of features (basin hearths, burned clay/charcoal pits, informal burned rock scatters) associated with a diverse tool kit. This site probably functioned as a generalized foraging camp. A similar function is postulated for site 41WM419 in the North Fork Reservoir. Although features are limited to informal clusters of burned rock, the associated tool assemblage and faunal remains suggest that the locale served as a foraging camp repeatedly occupied throughout the Circleville Phase.

18.2 San Geronimo Phase

Chronology

Four sites, three from the North Fork Reservoir and one from the Granger Reservoir, yielded components of the San Geronimo Phase. Of these four sites, the Hawes Site (41WM56) and the Cervenka Site (41WM267) provide the most representative samples for the respective reservoirs. The relatively small volume of matrix removed at sites 41WM57 and 41WM304 introduces a degree of bias to those samples.

The relative contemporaneity of the above assemblages is based on the occurrence of similar diagnostic projectile point types within both reservoirs. Hoxie, Uvalde, Wells, "Tortugas", and Groups 10, 12, and 13 are projectile points common to the assemblages of both reservoirs. Andice points, although found elsewhere in the Edwards Plateau region, were recovered only from the Cervenka Site as were the previously undefined Group 9 specimens. Martindale points, on the other hand, were recovered only in the North Fork Reservoir. Radiocarbon dates from the Cervenka Site (41WM267) (Table 7.1-1) indicate that the above projectile point styles were utilized between 5000 and 6000 B.P. All, except the "Tortugas" specimens, are specific to this time period.

Artifact Assemblages

Stylistic differences between the assemblages of the two reservoirs are notable during the San Geronimo Phase, especially the differences in the presence of diagnostic projectile point types. These differences may not be important because of the limited samples, but stylistic differences within a particular type, (such as the Hoxie points) are noticeable. Beveling and serration of the blade edges and an expanding or flared stem are traits more characteristic of the specimens of the Granger Reservoir assemblages. This particular set of characteristics also remains distinctive of the subsequent Clear Fork Phase.

The other tool classes from the two reservoirs reflect a pattern of variability similar to that of the projectile points. Inter-assemblage variability is not unusually great. Intra-class variability between reservoirs, however, is shown in a cumulative graph (Fig.18.2-1). Tool fragments and projectile points are not included in the following cumulative graphs. Therefore, of the 230 tools recovered from site 41WM267, 157 were used in the cumulative graph. Seventeen tools of a total of 41 from site 41WM57 and 68 tools of a total of 196 tools from site 41WM56 comprise the data for Fig. 18.2-1. The small sample size from site 41WM57 may account for differences shown by that assemblage.

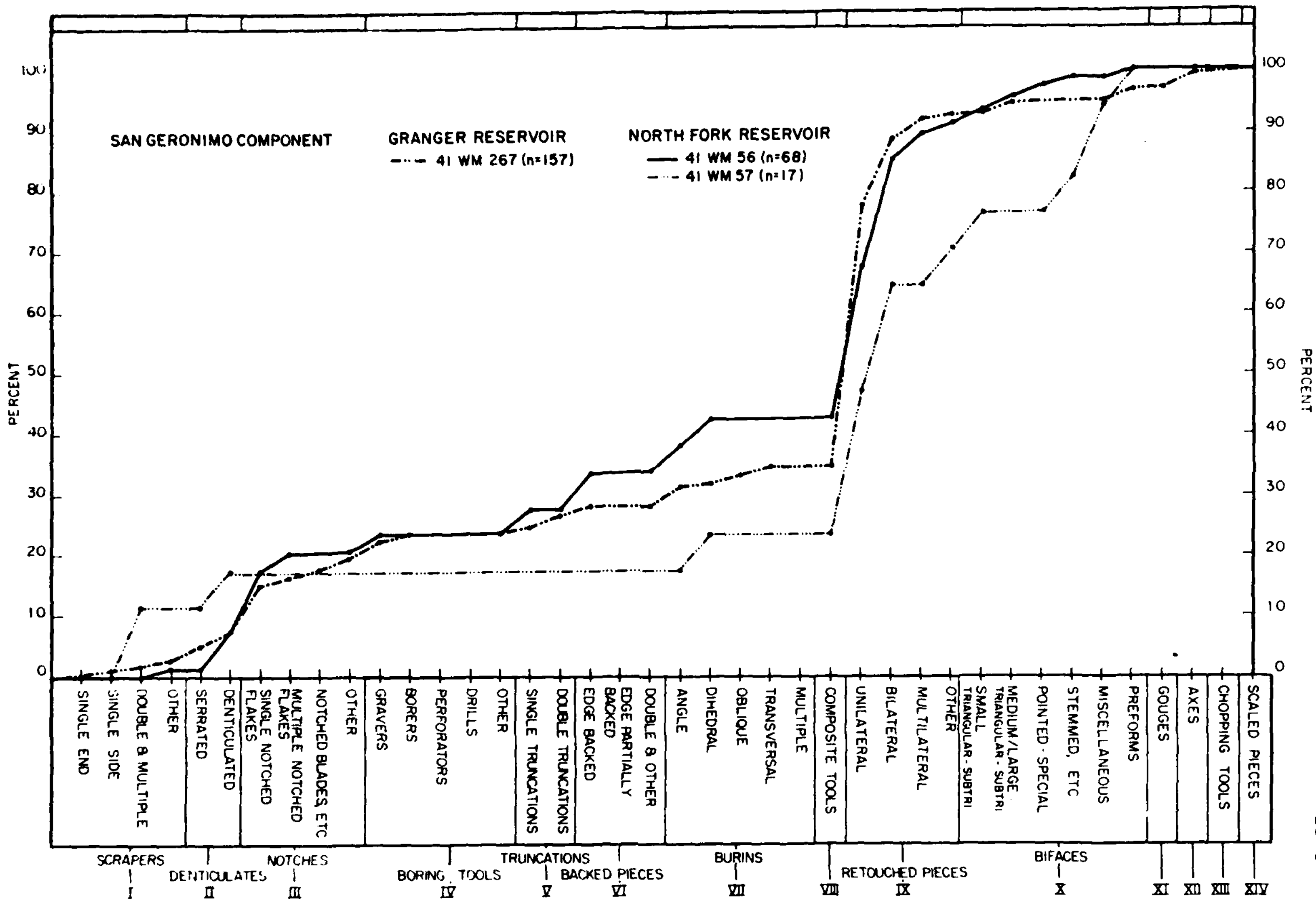

Figure 18.2-1 Cumulative Graph of San Geronimo Components.

Some tool classes appear in almost the same percentages in both reservoirs; such as scrapers, denticulates, gravers, truncations and burins. Scrapers are rather scarce in both reservoirs, but in the Granger Reservoir they are mainly single scrapers, whereas in the North Fork Reservoir they are mostly double scrapers. Gravers in the North Fork Reservoir are mainly oblique, while they are on the flake edge in the Granger Reservoir. Borers are exclusively from site 41WM267. Truncations are mostly distal in the North Fork assemblage, while they are mostly proximal in the Granger Reservoir, which is very unusual. Burins occur in a wide variety in both reservoirs, although oblique burins are absent in the North Fork Reservoir.

Some marked differences occur between the assemblages. First there is the large discrepancy between retouched pieces and biface fragments. In the North Fork Reservoir, more than 50% of the tools are biface fragments, 22% are retouched pieces. The reverse is true for the Granger Reservoir, where 51% of the tools are retouched pieces and only 13% are biface fragments. This difference does not show in the cumulative graph, because the biface fragments were not included in these diagrams. The Granger Reservoir also has much less complete bifaces and preforms (9% versus 20% restricted) than the North Fork Reservoir although axes do occur. There are noticeably more notched pieces in the Granger Reservoir, while backed pieces and burins are slightly lower in numbers. Axes and chopping tools were not found in the North Fork Reservoir.

There are also some differences in the cores, which are more numerous in the Granger Reservoir. Core types differ; single platform cores are predominant in the North Fork Reservoir, while multiple platform cores are in the Granger Reservoir. These differences may reflect the differing availabilities of raw material between the two reservoirs. Primary reduction at the North Fork Reservoir was conducted on the upland ridges where the choice of raw material was unlimited. In the Granger Reservoir choices were more limited. Consequently, the limited number of choice pieces of raw material were brought to a site for reduction into tools.

The marked differences in the presence of retouched pieces and biface fragments between the two reservoirs may be related to the availability of raw material. Many of the biface fragments are rejects of the lithic reduction sequence. Where the availability of raw material is literally unending (North Fork Reservoir), tool production and subsequent rejection of errors or undesirable pieces are likely to be common activities. Where availability is more restricted (Granger Reservoir), tool production will still be a necessary activity, but production rates will be lower and more care will be taken to conserve the available raw material.

The functional implications of the larger numbers of retouched pieces and the presence of axes and chopping tools solely in the Granger Reservoir are not immediately evident. Perhaps, the axes and chopping

tools were used to butcher the bison hunted during this phase or to split long bones for marrow. On the other hand, they may have been used for woodworking. Intensive wear pattern analysis may give insight into the function of these tools.

From a more general perspective, however, the same diversity of tools with only a few exceptions, is present within both reservoirs during this phase. The differences lie within the types of the major tool classes. Consequently, the inter-reservoir differences may be the result of stylistic, rather than functional differences.

Settlement/Subsistence Patterns

The densities of lithic debitage and tools (Tables 16.9-2, 17.9-2) are very low in both reservoirs for the long time span involved. The varying tool/debitage ratios for these assemblages can hardly be used to assign differing functional designations to these assemblages. Although tool and debitage densities are related to intensity of occupation and site function, these relationships are rarely direct. Cultural and natural processes often distort the archaeological context. These assemblage densities may be radically skewed by the different sedimentation regimes of the respective site situations. Using the calibrated radiocarbon dates from the San Geronimo component of site 41WM267, an approximate sedimentation rate of 32 cm/100 years can be calculated. Unfortunately, no equivalent data are available for the San Geronimo components of the North Fork Reservoir. Data from the following Clear Fork component of site 41WM56, however, denote a much slower sedimentation rate of 2.8 cm/100 years. Considering the topographic situation of site 41WM56, it is highly unlikely that sedimentation rates were significantly higher during the San Geronimo component. If this is a correct assumption, the differing densities between the two reservoirs are relatively meaningless. The higher densities of debitage and tools within the North Fork assemblages merely reflect the repeated utilization of a relatively stable surface. Therefore, the character and nature of the North Fork occupations are not necessarily distinct from those of the Granger Reservoir.

The faunal assemblages of these components reflect a diffuse foraging subsistence strategy. Aquatic, woodland, and grassland species are represented (Chapter 15.7) in both reservoirs. Prairie fauna, such as bison, prairie chicken, and pronghorn antelope, dominate the Granger assemblage while woodland and aquatic species dominate the North Fork assemblages.

Evidence of extensive utilization of the local floral resources is lacking except for the presence of two mano fragments from the Hawes Site. Perhaps, wooden mortars and pestles were utilized. The lack of macro-botanical remains from these components however, suggests that floral resources may not have been an important part of the subsistence strategy.

Features of this phase consist of informal clusters of burned rock, basin-shaped hearths, and concentrations of ash and heat altered soil. All three feature types are present in the Granger Reservoir while only informal clusters of burned rock were discovered in the North Fork sites. The relatively low densities of lithic debitage and tools (Tables 16.9-2, 17.9-2) associated with these features implies a mobile adaptation with site occupation being quite ephemeral. The broad horizontal expanse of these components and the super-positioning of living surfaces further indicates the recurrent utilization of a site locality. In both reservoirs the diversity of the tool assemblages and the associated faunal resources suggests that a generalized foraging subsistence strategy was being practiced by small bands of hunter-gatherers.

18.3 Clear Fork Phase

Chronology

The Hawes Site (41WM56) and the Cervenka Site (41WM267) provide the primary data base for the inter-reservoir comparisons of the Clear Fork components. Sites 41WM57, 41WM73, and 41WM304 from the North Fork Reservoir and the Bryan Fox Site (41WM124) from the Granger Reservoir also contained Clear Fork components. Although a time frame of 4,000 - 5,000 B.P. for the Clear Fork Phase is acceptable for these assemblages (Table 7.1-1), the timing of the transition to the Round Rock Phase is still largely conjectural. The association of diagnostic projectile point types and radiocarbon dates from the Hawes Site suggest that a transition date of 3,500 B.P. might be more appropriate for the San Gabriel River Valley. These limited data can hardly be regarded as conclusive, however. Numerous sequences of occupational debris and radiocarbon dates are needed if we are to understand the nature and evolution of the adaptive strategies within Central Texas.

The subtle differences between the diagnostic elements of the San Geronimo Phase of both reservoirs become more pronounced during the Clear Fork Phase. In the North Fork Reservoir the commonly recognized diagnostic elements include Bulverde, Nolan, Travis and Group 14 projectile points. Only a very few of these traditionally recognized diagnostics of the Clear Fork Phase are present within the Cervenka Site. Instead, the projectile points of the Cervenka assemblage share morphological characteristics with specimens from assemblages found east of the Balcones Escarpment in the prairie region. Dawson points and previously undefined Groups 1,2,4,5,7,8, and 11 are present. These same projectile point forms are only minimally represented within the North Fork Reservoir (Tables 16.9-1, 17.9-1).

<u>Artifact Assemblages</u>

The small sample sizes from many of the components of this phase introduce a degree of bias to any inter-assemblage comparisons. This sampling bias definitely skews the resulting cumulative graph (Fig. 18.3-1). Sites 41WM73 and 41WM57 yielded 33 and 21 tools, respectively. Excluding the projectile points and biface fragments allowed only 16 tools from each site to be used in the cumulative graph. Of the 188 tools collected from site 41WM304 only 37 are included in the graph. The minimal sample from site 41WM124 (n=13) yielded only seven tools for the purposes of the cumulative graph. Only sites 41WM56 (n=437) and 41WM267 (n=415) provided samples which are sufficiently large for adequate comparisons. It should be noted that with such large samples, the tool assemblages from the respective reservoirs are nearly identical.

At a less generalized level, however, some differences are still apparent between the two reservoirs. The same discrepancy between retouched pieces and biface fragments noted for the San Geronimo component is still evident, but to a lesser degree. Retouched pieces and biface fragments occur in almost equal amounts in the Granger Reservoir in contrast to the vast predominance of biface fragments over retouched pieces in the North Fork Reservoir. Scrapers are much more abundant in the latter reservoir, although the subtypes are the same in both reservoirs. In contrast, notches and denticulates are more frequent in the Granger Reservoir, and especially noteworthy are the serrated pieces which are totally absent in the North Fork Reservoir. There are no similarities in the boring tools. The North Fork Reservoir yielded only a few drills and one pick, while the Granger Reservoir has only gravers and borers. Truncations occur with the same frequency, but in the Granger Reservoir they are predominantly distal dorsal, while in the North Fork Reservoir there is no preference. There are as many distal as proximal truncations, and several were made by ventral retouch. Backed pieces are slightly less important than in the San Geronimo components, and also slightly more frequent in the Granger Reservoir. Burins occur less often, and in more restricted variations. The majority are still single angle burins on snap; the other subtypes are rare. Complete bifaces and preforms are slightly more abundant in the Granger Reservoir, especially the finished bifaces. Interesting is the fact that both Reservoirs have a number of bifaces with accentuated working ends. The remaining tool classes are rare. Scaled and battered pieces occur in both reservoirs, unifaces only in the North Fork Reservoir, gouges and chopping tools only in the Granger Reservoir.

Cores are generally much less abundant than during the San Geronimo Phase and the majority of them came from the Granger sites. Both reservoirs yielded a large number of single platform cores, but while these are predominant in the Granger Reservoir, double platform cores are in the North Fork Reservoir. The multiple platform cores are more frequent in the former. Other core types are rare.

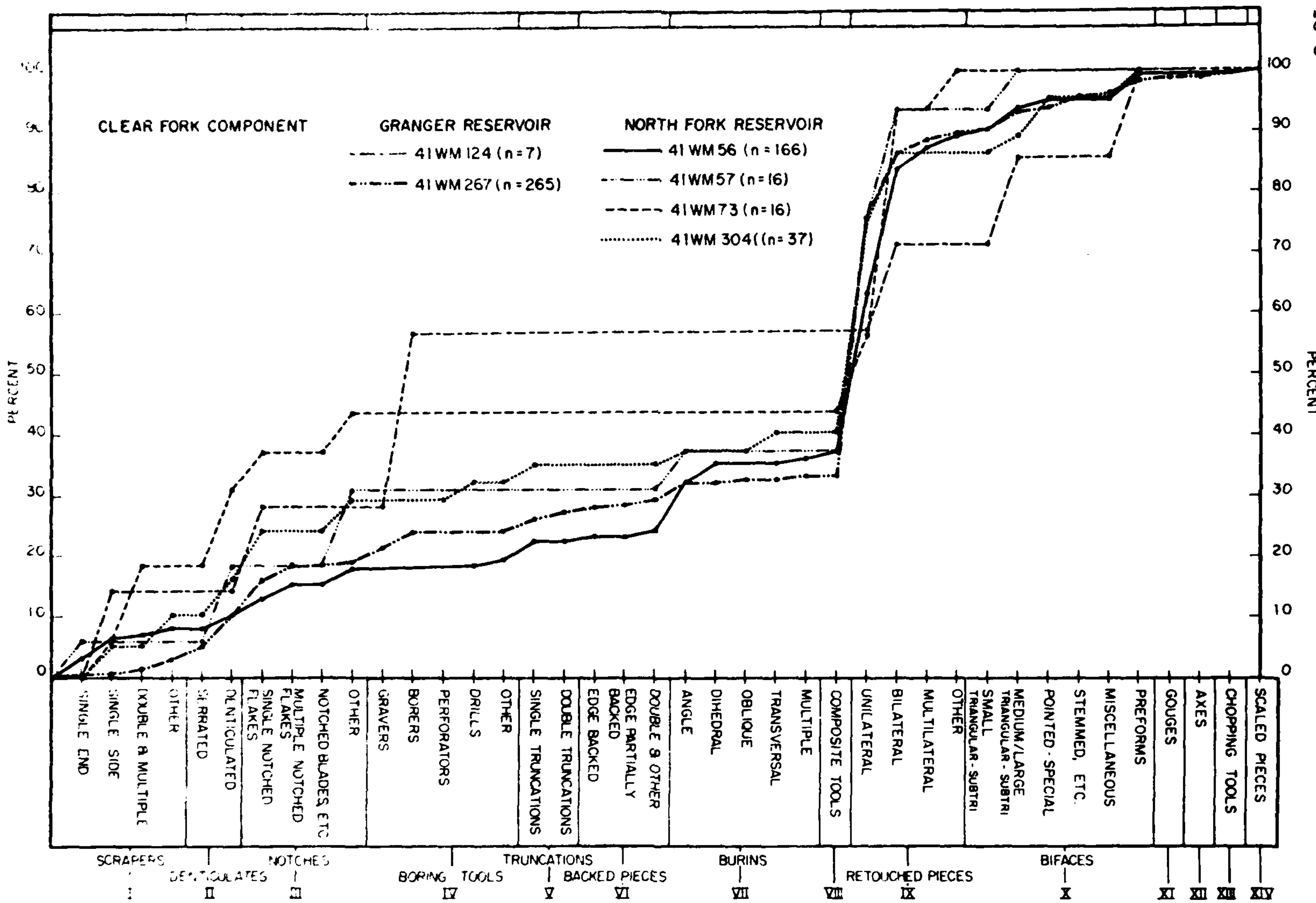

Figure 18.3-1 Cumulative Graph of Clear Fork Components.

For the most part inter-reservoir differences in tool classes are few. Gravers, borers, serrated pieces, gouges, and chopping tools occur only in the Granger Reservoir. Drills and picks occur only in the North Fork Reservoir. The exact functional implications of these differences are unknown. Perhaps, the presence of gouges and chopping tools in the Granger Reservoir components denotes a greater emphasis on woodworking. Whatever the functional implications, these differences do not appear to be especially significant for these tools are not the best represented tool classes of the assemblages.

Interestingly, the stylistic variability of the types within these classes are not particularly significant when comparing the reservoirs. The inter-reservoir patterns of the preceding San Geronimo Phase are not evident in the Clear Fork Phase. During the San Geronimo Phase the stylistic differences noted between the projectile points of the two reservoirs were accented by the stylistic differences exhibited by the types within each tool class represented in both reservoirs. In these Clear Fork Phase assemblages the stylistic differences between the projectile points of each reservoir become even more pronounced while the stylistic variability of the other tool classes becomes less significant.

Whether the stylistic differences in the projectile point class represent adaptations to different hunting conditions, actual social boundaries, or a combination of these factors is very difficult to interpret. Since the predominant specimens of each reservoir district are minimally represented in the other, some level of interaction is indicated. The exact nature of this interaction may never be known. It is not improbable however, that during the Early Archaic period distinctive macro-bands were adapting to the Blackland Prairie and Edwards Plateau regions, respectively. Inter-group contact may have been frequent. Territorial boundaries probably were not very rigid.

Settlement/Subsistence Patterns

Occupational intensity increases significantly in both reservoirs during this phase. For the most part tool and debitage densities are significantly higher than those of the previous San Geronimo components (Tables 16.9-2, 17.9-2). The relatively low values for sites 41WM57 and 41WM304 reflect the sampling of the central areas of burned rock middens. Consequently, intra-site functional differences may be depicted rather than any significant inter-site differences. Except for site 41WM57, the equally low tool/debitage ratios for all of the sites indicate very little functional differentiation among the sites. Each site reflects a generalized foraging economy in which sites are repeatedly utilized for varying lengths of time. The Hawes Site (41WM56) with its variety of features and the increased presence of ground stone tools is the only site which stands out as possibly functioning as a base camp.

Huge accumulations of burned rock begin to form at the North Fork Reservoir sites during this period. The character of these accumulations, however, differs from site to site, and the functional correlates of these structural differences are not easily understood. These same massive accumulations of burned rock are not initiated in the Granger assemblages at this same period, although informal clusters of burned rock and more dense, unpatterned scatters of burned rock are present. Once again, differing sedimentation rates of the respective site situations may have contributed to this inter-reservoir difference. On the other hand, the processing requirements of certain food resources such as the acorns of the Edwards Plateau region, may have contributed to the distinctive character of the North Fork assemblages. The problems of delineating the processes contributing to the formation of the burned rock middens are discussed more fully later (Chapter 20 .0).

The fauna from the Clear Fork components of both reservoirs indicate that all available habitats (aquatic, woodland, and grassland) were being exploited. The utilization of aquatic species during this phase is the most intense of any period of the occupational sequence within the San Gabriel River Valley. Woodland species continue to be the dominant food resource. As expected, prairie resources are better represented in the Granger Reservoir with the exception of bison which is in the North Fork Reservoir. In the Granger Reservoir the exploitation of the prairie resources focused on smaller game such as prairie chicken, ground squirrel, and jackrabbit.

The foraging subsistence strategy in the North Fork Reservoir includes the exploitation of floral resources much as acorns, pecans, walnuts, prickly pear, hackberry, and goosefoot. The sudden increase in the utilization of these floral resources is further documented by a parallel increase in the number of ground stone artifacts recovered from the North Fork components (Table 14.6-1). The Granger Reservoir components do not exhibit a similar trend, although the limited number of components from the Granger Reservoir may introduce a degree of bias to this comparison. Nevertheless, given the intensity of utilization of the Cervenka Site one would expect a much larger number of ground stone tools if floral resources had been an important part of the subsistence strategy. Based on the available evidence, floral resources were not an important part of the diet of occupants of the Granger Reservoir area.

The exploitation of the North Fork drainage was apparently more diversified than that of the Granger Reservoir. This difference may reflect the differing production capabilities of the two environmental zones. The Blackland Prairie region would have offered a more limited selection of usable floral resources than the Edwards Plateau region. Consequently, the floral resources comprise a significantly smaller portion of the subsistence base in the Granger Reservoir.

This intensive use of a wider range of food resources during the Clear Fork Phase might represent a populations response to a deteriorating environment. The increasing densities of cultural debris, however,

indicate that increasing population pressures might be an equally likely stimulus to such a diversification. Increasing population pressures, as indicated by the more intensive occupation of these sites, may have compelled the local population to seek out a broader spectrum of food resources. Although this latter hypothesis is more appealing than the former, neither can be effectively tested with the presently available data base. Several radiocarbon dated occupational sequences with associated pollen and gastropod columns would be needed to verify this impression from the San Gabriel data.

18.4 Round Rock Phase

Chronology

Comparability of sample size is a limiting factor for the inter-reservoir comparisons of this phase. The Loeve-Fox Site (41WM230) and site 41WM163 yielded limited samples from the Granger Reservoir. In the North Fork Reservoir sites 41WM73, 41WM56, 41WM57 and 41WM304 provided a much larger data base. The recognition of the Round Rock components within both reservoirs relies almost totally upon the presence or absence of Pedernales type points. A single radiocarbon date of 3225 $\pm$ 75 B.P. (UGa-2480) is stratigraphically associated with Pedernales and Bulverde points at the Hawes Site (41WM56). The total lack of radiocarbon dates for this same time period from the Granger Reservoir leaves an important question unanswered. Is the intensity of occupation in the Granger Reservoir significantly diminished during this time period or are the diagnostic artifacts merely different than those of the Edwards Plateau region? The stylistic differences between the reservoirs during the earlier Clear Fork Phase supports the latter possibility. On the other hand, the presence of a limited number of Pedernales points associated with low densities of tools and debitage (Tables 16.9-2, 17.9-2) in the Granger Reservoir assemblages denotes a less intensive occupation of the area. The combination of limited samples and lack of any absolute chronological data, however, makes either conclusion rather tenuous.

Artifact Assemblages

Of the excavated sites in the Granger Reservoir, only the Loeve-Fox Site and site 41WM163 yielded 39 and 6 tools, respectively, from Round Rock components. In the North Fork Reservoir sites 41WM73 (145) tools, 41WM56 (143 tools), 41WM57 (59 tools), and 41WM304 (46 tools) provide a much larger data base for this phase. Due to this discrepancy only limited comparisons of the respective tool assemblages can be made, although more general statements concerning the prehistoric occupation of each of the reservoir districts are possible.

A comparison of the tool kits from the respective reservoirs indicates that biface fragments and retouched pieces are again the two

largest tool classes in both reservoirs (Fig. 18.4-1). It is interesting to note that in both reservoirs there is an almost equal number of unilaterally and bilaterally retouched pieces. When one excludes the two above tool classes, there are few areas of similarity between the two reservoirs. Of course, the small size of the Granger Reservoir samples precludes any conclusive statements concerning functional differences.

In the North Fork Reservoir scrapers, denticulates and notched pieces are the dominant tool classes, while in the Granger Reservoir these are the burins, truncations and complete bifaces and preforms. Boring tools are very scarce in both reservoirs with only one pick in the Granger Reservoir and one graver and a few drills in the North Fork Reservoir. Backed pieces are also rare in both reservoirs. Axes, gouges, chopping tools, scaled and battered pieces and unifacials were found only in the North Fork Reservoir. Cores are also scarce in both reservoirs, and no preference for a particular core type was observed.

Settlement/Subsistence Patterns

The massive accumulations of burned rock continue to be a distinguishing characteristic of the North Fork assemblages during this phase. Deep basin-shaped hearths or ovens and informal clusters of burned rock were the only distinct features in these accumulations. Basin hearths, burned clay/charcoal pits, and lenses of burned rock are characteristic of the Granger assemblages. Whether these differences are related solely to the differential intensity of occupation or functional differences is unclear. The intensity of occupation was merely a contributing factor, but the burned rock middens may also be the product of specific functions. The possible nature of those functions will be discussed in a later section.

Exploitation of the local fauna remains quite diversified during this phase. The aquatic, grassland, and woodland habitats are each utilized although the relative importance of the aquatic species decreases significantly. Floral resources such as hackberry seeds, acorns, and pecans also continue to be exploited by the inhabitants of the North Fork Reservoir area. As in the preceding phase, the Granger Reservoir assemblages provide very little evidence of the exploitation of floral resources. Once again ground stone tools are common in the North Fork Reservoir, but almost nonexistant in the Granger Reservoir assemblages (Table 14.6-1).

If the available data from the Granger Reservoir are representative of the actual situation during the Round Rock Phase, utilization of the two reservoir districts differs significantly. Occupational intensity, as measured by debitage and tool densities, drops drastically in the Granger Reservoir area while it remains at a high level in the North Fork drainage. The adaptive strategy of the latter portion of the

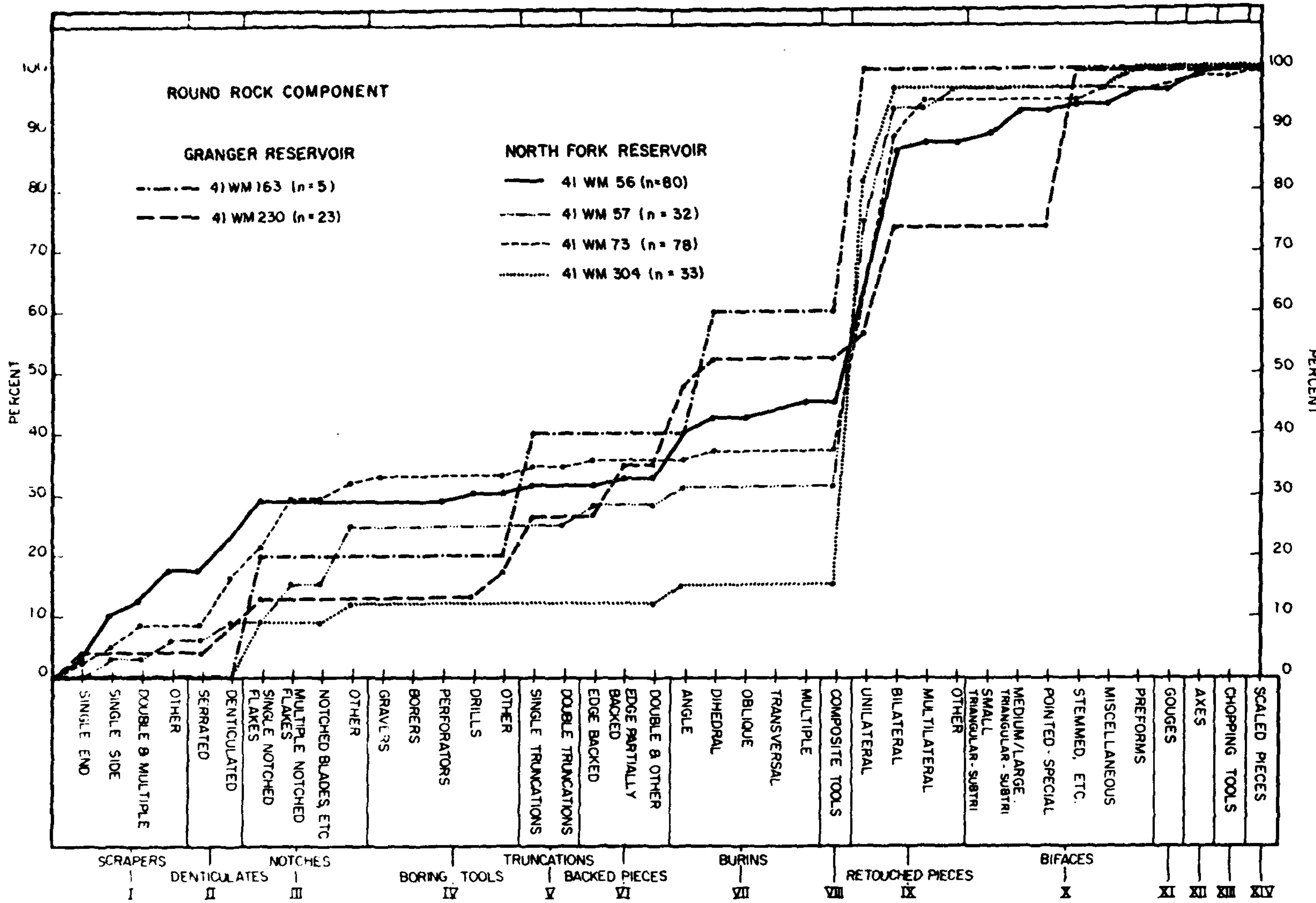

Figure 18.4-1 Cumulative Graph of Round Rock Components.

preceding Clear Fork Phase apparently continues to be viable only in the North Fork Reservoir. Why the Granger Reservoir area is unattractive for human occupation during this period is not immediately clear.

18.5 San Marcos Phase

Chronology

Two assemblages from the North Fork Reservoir (41WM56 and 41WM73) and four from the Granger Reservoir (41WM124, 41WM163, 41WM230, and 41WM267) comprise the comparative sample for the San Marcos Phase. In the North Fork Reservoir the recognition of this phase relies upon the presence of Montell, Marcos, Williams, Castroville, and Marshall point types. These same projectile point styles are found in the Granger Reservoir assemblages. Two radiocarbon dates are available from these assemblages. The sample from the Bryan Fox Site (41WM124) yielded a date of 1745 ± 85 B.P. (UGa-2476). Its context is at the interface of the vertical distributions of diagnostic elements of the San Marcos and Twin Sisters Phase, respectively. The other date of 1700 ± 120 B.P. (R1-1586) may represent the upper portion of the San Marcos component of the Cervenka Site. The initial appearance of the diagnostic projectile points of this phase is undated in both reservoirs. Consequently, the Round Rock - San Marcos transition remains to be well documented.

Artifact Assemblages

In the North Fork Reservoir, sites 41WM56 and 41WM73 yielded minimal samples of thirty-seven and twenty tools, respectively. Sites 41WM124 (67 tools), 41WM163 (10 tools), 41WM230 (42 tools), and 41WM267 (231 tools) provided a more adequate sample from the Granger Reservoir. Projectile points are not included in these totals. Artifact assemblage comparisons are necessarily tempered by the apparent problems of small sample sizes. The notable differences among the cumulative profiles of these assemblages (Fig. 18.5-1) may result from sampling bias. However, it is interesting to note that the North Fork assemblages and that of the Cervenka Site exhibit less variability than the assemblages within the Granger Reservoir only.

As has happened for earlier periods, one of the major discrepancies between the two reservoirs is the reversed frequency of occurrence between biface fragments and retouched pieces. Again, biface fragments are by far the largest tool class in the North Fork Reservoir, while retouched pieces dominate in the Granger Reservoir.

When excluding retouched pieces and biface fragments, scrapers form the most important tool class in the North Fork Reservoir, with notched pieces in the Granger Reservoir. The various subtypes, however, are very similar in both reservoirs. Scrapers, also become a more frequent

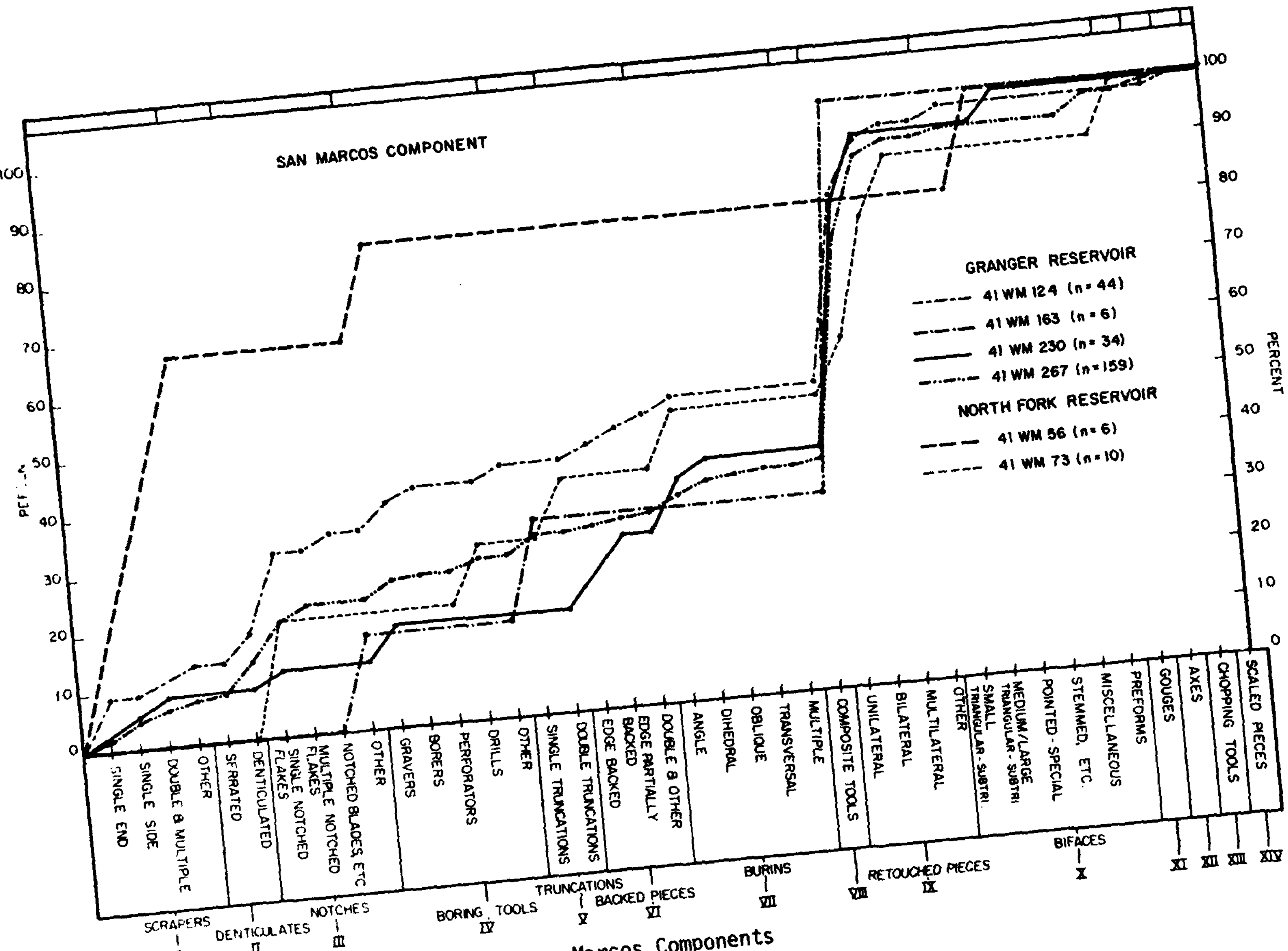

Figure 18.5-1 Cumulative Graph of San Marcos Components

element in the Granger assemblages during this phase. This significant increase in the relative frequency of scrapers over the previous occupations of the Granger Reservoir may be related to the presence of bison in most of the components of this phase. More hide working could have necessitated the use and resulting discard of a higher frequency of scrapers.

Another frequency reversal between the assemblages of the two reservoirs occurs between truncations and backed pieces. Backed pieces are more important in the Granger sites while truncations are in the North Fork assemblages. Interestingly, axes appear in both reservoirs in low numbers. Complete bifaces, as usual, are also better represented in the North Fork assemblages.

Settlement/Subsistence Patterns

Tool and debitage densities for this phase (Tables 16.9-2, 17.9-2) are as high or higher than those of the previous phase. As during the previous phases, these densities remain higher in the North Fork Reservoir. Differential sedimentation rates for the two reservoir districts may be producing these differences. The relatively consistent tool/debitage ratios for both reservoirs suggest that sites in either reservoir served the same purpose (foraging camps). The greater densities of artifacts at sites in the North Fork Reservoir may be related to the reoccupation of site situations in which the rates of alluvial deposition were very low; consequently, the reoccupation of the same surface would produce inflated artifact density values which would have no necessary relationship to the function of the site.

Massive accumulations of burned rock, similar to those of the North Fork Reservoir, appear in the Granger Reservoir for the first time during this phase. Deep, basin-shaped pits or ovens also occur for the first time. The presence of these features at a single documented site, however, does not necessarily represent a significant change in the exploitation of the Granger Reservoir District. Apparently, the Bryan Fox Site was an intensively utilized locale during this phase, but its relationship to similar sites in the North Fork Reservoir remains unclear.

The prehistoric occupants of both reservoir districts exploited all of the available resource environments: wooded bottomlands, upland prairie, the stream and sloughs. The relatively low densities of individuals and the predominance of small mammals in the faunal assemblages (Chapter 15.7) suggest that larger game may not have been overly abundant during this phase. A diffuse foraging economy persists, but it apparently is operating at a lower level of productivity.

Unlike previous phases, the differences in the exploitation of floral resources are not so significant. The remains of acorns, grasses, and hackberry seeds are more abundant in the Granger assemblages while acorns, pecans, and prickly pears are represented in the North Fork assemblages. There is an almost complete absence of ground stone tools in both reservoirs during this phase.

It is during this phase that evidence of contact with more distant areas is present. A conch columella bead and a Marginella shell from the Loeve-Fox Site probably were brought inland through an indirect trade network. The conch columella bead is associated with a cremation which is also the earliest evidence of the interment practices of the inhabitants of the San Gabriel River Valley. Evidence of outside contacts and interment practices were not discovered in the North Fork assemblages. Nevertheless, the appearance of these items during this phase may indicate that the local bands were ranging over as larger territory in search of adequate food resources. This process may have brought about more frequent encounters with bands downstream which had more direct contacts with the coastal areas.

18.6 Twin Sisters Phase

Chronology

Five sites from the Granger Reservoir and three from the North Fork Reservoir yielded components of the Twin Sisters Phase. Sites 41WM53 and 41WM328 are occupied for the first time in the North Fork Reservoir. The Hawes Site (41WM56) also remains a favored site location. In the Granger Reservoir sites 41WM124, 41WM163, 41WM230, 41WM258, and 41WM267 are inhabited.

This phase of occupation of the San Gabriel River Valley is the most well dated of the entire occupational sequence. Nine radiocarbon dates from the Loeve-Fox Site place the occurrence of Darl, Fairland, and Ensor type points between 1750 and 1250 B.P. (Appendix J). Additional dates from the Bryan Fox Site (41WM124) (Chapter 7.1); the Hoxie Bridge Site (41WM130) (Bond 1978:122), and the Dobias-Vitek Site (41WM118) (Eddy 1973:34-36) indicate a similar time range for these diagnostic projectile points. Of these projectile point styles, the Darl point dominates these assemblages. The Fairland, Ensor, and Fairland/Ensor varieties are not well represented.

In the North Fork Reservoir, sites 41WM53 and 41WM328 yielded five dates which place Darl, Fairland, Ensor, and Fairland/Ensor points within this same time frame (Table 7.1-1). The Fairland/Ensor variant is much better represented within these assemblages, although Darl points are present. Darl points appear later in the occupational sequences of the North Fork Reservoir assemblages than they do in the Granger Reservoir assemblages (Tables 16.9-1, 17.9-1).

Artifact Assemblages

Once again comparison of relative artifact frequencies must be tempered by the ever present problems of sample size. This component was represented in the North Fork Reservoir by 106 tools at site 41WM53, 134 tools at site 41WM56, and 63 tools at site 41WM328. Sites 41WM124

(n=78), 41WM163 (n=36), 41WM230 (n=197), 41WM258 (n=10), and site 41WM267 (n=59) from the Granger Reservoir yielded samples of varying adequacy for comparative purposes (Fig. 18.6-1).

Unlike the preceding phases the biface fragments form the predominant tool class in both reservoirs. Retouched pieces follow in frequency of occurrence, although the difference in occurrence between the tool classes is much smaller in the Granger Reservoir assemblages. The unilaterally retouched pieces are most important at all sites. When excluding the above two classes, there are some striking differences between the two reservoirs. Burins are clearly a very important tool class in the North Fork Reservoir (restricted % = 24) while they are poorly represented in the Granger Reservoir (restricted % = 7). The subtypes are similar, with single angle burins predominant, although there is the total absence of dihedral burins in the Granger Reservoir.

In the Granger Reservoir, complete bifaces and preforms are much more frequent than was the case in the preceding cultural components, while the increase in the North Fork Reservoir was only moderate. Complete bifaces were decidedly smaller in the Granger Reservoir. The notched pieces are much the same in both reservoirs. Denticulates occur with about the same frequency, and there are several serrated artifacts in the Granger Reservoir, which were totally lacking in the North Fork Reservoir. Truncations are slightly more frequent in the North Fork Reservoir, and are mostly proximal, in contrast to the mainly distal truncations of the Granger Reservoir. Backed pieces are slightly more frequent in the Granger Reservoir. Boring tools are present in both reservoirs, although they are less prominent in the North Fork Reservoir. Gravers were found in both assemblages, but they are more numerous in the Granger Reservoir. Drills and perforators come from the North Fork Reservoir only. The chopping tools, relatively important in the Granger Reservoir, are totally lacking in the North Fork Twin Sisters components. Cores are typically less abundant in the North Fork Reservoir.

Although there are apparent differences in the relative frequencies of certain artifact classes between the two reservoir areas, the diversity or range of tools in both reservoirs is quite similar. The same types of functions probably were being performed in both reservoirs. The differences in the types of each tool class represented in both reservoirs may indicate some stylistic separation of the assemblages of the reservoir districts. A stylistic difference also is suggested by the relative frequencies of the projectile point styles for the two reservoirs. However, the significance of the inverse relationship of the frequencies of Fairland/Ensor and Darl points between the two reservoirs may be related to temporal differences in the occupation of each reservoir. Since the Darl points are more common near the end of this phase, the high proportion of Fairland/Ensor points from the North Fork Reservoir indicates that the area was most intensively inhabited during the early portion of the phase. The Granger Reservoir was apparently occupied more intensively during the latter portion.

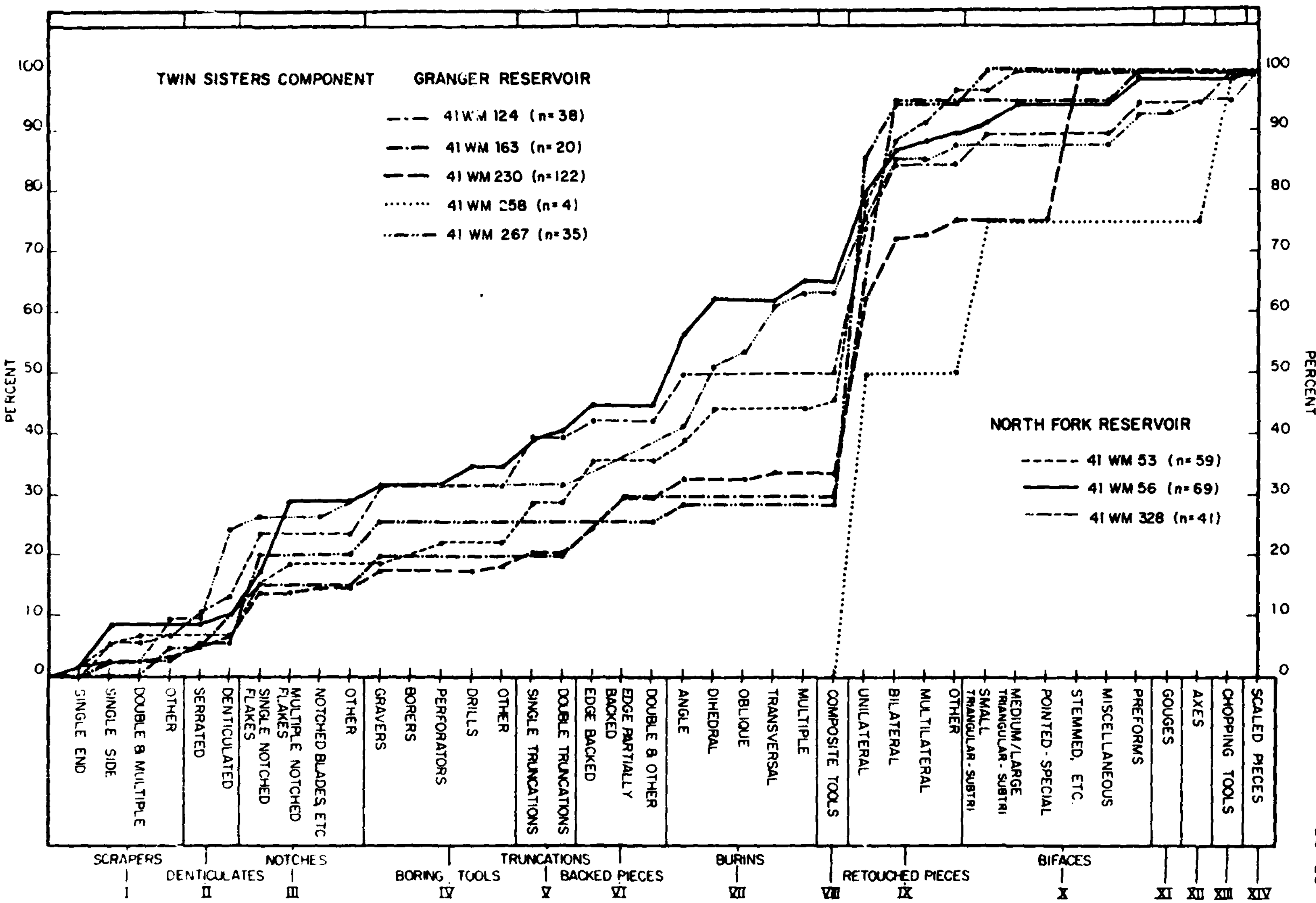

Figure 18.6-1 Cumulative Graph of Twin Sisters Compenents

Settlement/Subsistence Patterns

Natural levees and other riparian situations become more favored site locations during this phase. Sites farther away from the main stream channel (41WM267, 41WM258) exhibit significantly lower densities of cultural debris. Occupational intensity, as reflected by tool and debitage densities, varies greatly among the assemblages of the two reservoirs (Tables 16.9-2, 17.9-2). Some sites were apparently occupied more frequently, although the differing sedimentation regimes of the sites may have been a contributing factor to these differences. For the most part the densities of lithic and faunal remains indicate ephemeral but recurrent utilization of these sites.

In the North Fork Reservoir shallow basin-shaped hearths and informal clusters of burned rock are the characteristic features. Apparently, the massive accumulations of burned rock were enlarged, although at a much lower rate, during this phase. In the Granger Reservoir, a greater variety of features was evident. Deep, basin-shaped hearths or ovens are present along with smaller basin hearths, burned clay/charcoal pits, and arcuate hearths (Appendix J).

A diffuse foraging subsistence strategy was employed in both reservoir districts. Aquatic, woodland, and prairie fauna were exploited by the occupants of both areas. Woodland species were the predominant food resource. The floral remains from both reservoirs also reflect an intensive utilization of the wooded bottomlands. For the first time in the occupational sequence, ground stone tools are well represented in both reservoirs. The raw materials for the ground stone tools of the Granger Reservoir probably were procured through a trade network which extended westward through the North Fork drainage to the Colorado drainage and the Llano Uplift region. This evidence, together with the stylistic differences of the tool classes between the two reservoir districts, indicates that social contact between the two areas was probably frequent. Whether distinctive populations occupied these separate areas is a more difficult question which requires more well-dated samples from both the Blackland Prairie and the Edwards Plateau.

The temporal relationships of the occupations of both reservoirs may have an important effect on the significance of the above observations. If the shift of occupational intensity from the North Fork to the Granger Reservoir is real and not a result of sampling bias, then the noted stylistic differences may be due to temporal trends rather than boundaries to social interaction. Whether or not the hunter-gatherer population that had frequented the North Fork drainage early in this phase moved to the Granger Reservoir area remains conjectural. The sudden increase in the exploitation of floral resources in the Granger Reservoir may reflect the influx of hunter-gatherers who had previously relied on the floral resources of the North Fork drainage. The feasibility of this scenario, however, is seriously weakened by a lack of environmental data relating to the reasons for such a shift in population.

18.7 Austin Phase

Chronology

Five assemblages from the North Fork and Granger Reservoirs comprise the comparative data base for the Austin phase. In the North Fork Reservoir sites 41WM53 and 41WM328 yielded components containing the diagnostic Scallorn projectile points. The bigon-Kubala Site (41WM258), Loeve-Fox (41WM230), and site 41WM163, all from the Granger Reservoir, yielded assemblages containing Scallorn projectile points. Twelve reliable radiocarbon dates have been obtained for this phase. Six of these (Appendix J) place the Austin component of the Loeve-Fox Site (41WM230) between 1250 and 850 B.P. Three other dates from the Hoxie Bridge Site (41WM130) (Bond 1978) and the Dobias-Vitek Site (41WM118) (Eddy 1973) document occupations between 700 and 800 B.P. (Table 7.1-1). In the North Fork Reservoir a single radiocarbon date from site 41WM328 and two from site 41WM53 document the appearance of Scallorn points at approximately 1250 B.P. (Table 7.1-1). The time of termination of this phase in the San Gabriel River Valley remains largely conjectural. There appears to be an occupational hiatus between the known Austin components and the following Toyah Phase occupations.

Artifact Assemblages

Small samples of tools from the Austin Phase components render any inter-assemblage comparisons extremely tentative. A total of 49 tools from site 41WM53 and eight from site 41WM328 were recovered from the North Fork assemblages. In the Granger Reservoir, 15 tools were recovered from site 41WM163, 14 from the Loeve-Fox Site (41WM230), and only two from the Bigon-Kubala Site (41WM258). These sample sizes make any inter-reservoir comparisons quite futile. It may be noted, however, that the usual inverse relationship of retouched pieces and biface fragments between the two reservoirs remains. Retouched pieces continue to dominate the Granger Reservoir assemblages while biface fragments dominate the North Fork assemblages. Cores also remain more common in the Granger Reservoir assemblages (Fig. 18.7-1).

Settlement/Subsistence Patterns

Intensity of occupation, as indicated by the number of sites and the densities of lithic debitage and tools (Tables 16.9-2, 17.9-2), is quite low in both reservoirs during this phase. Sites apparently served as ephemeral foraging camps for small bands. The Granger Reservoir area was used more intensively, however. Occupations there exhibit a wider variety of features in the form of deep basin-shaped hearths, burned clay/charcoal pits, and a cemetary with cremated and non-cremated interments.

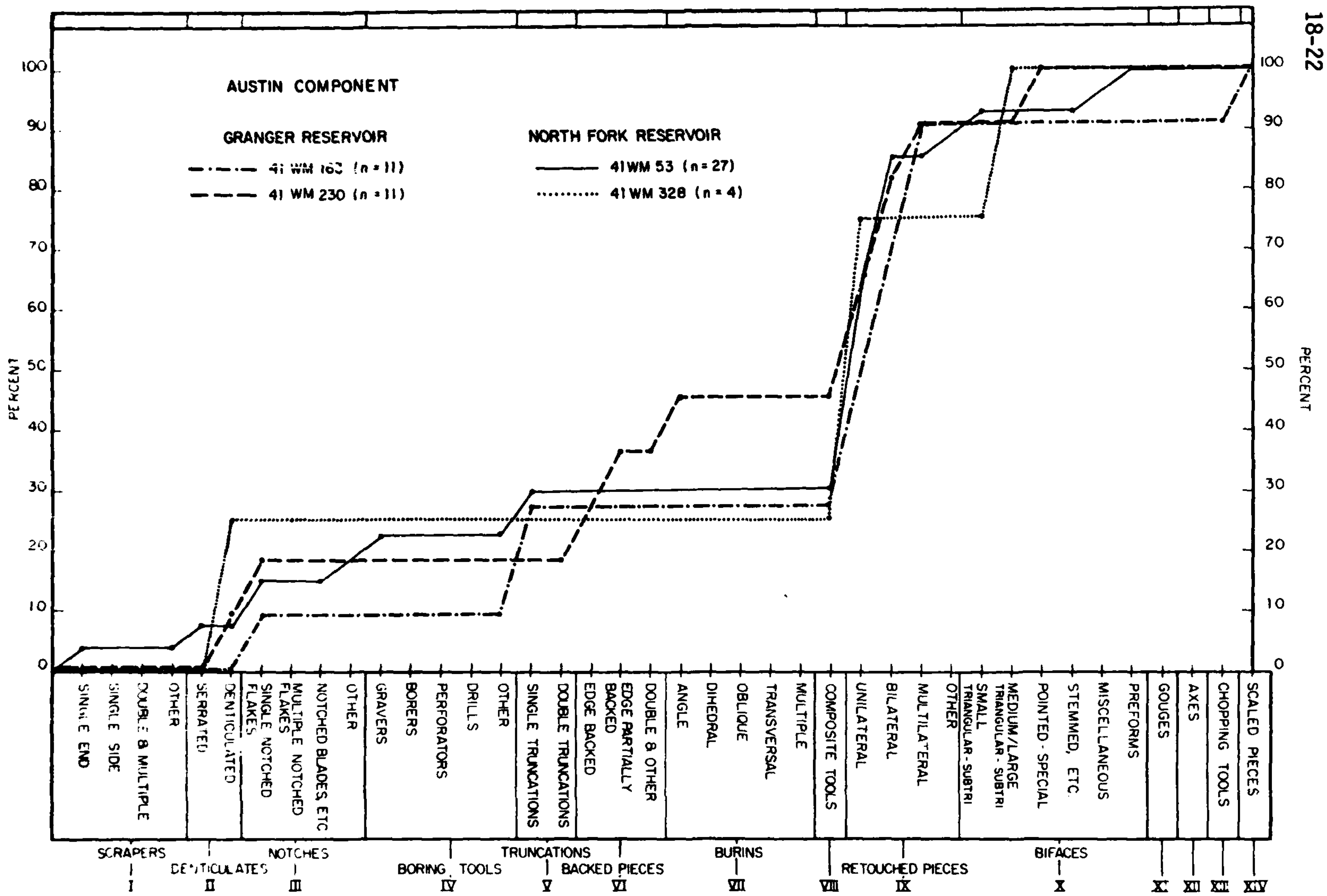

Figure 18.7-1 Cumulative Graph of Austin Components

Faunal and floral densities are relatively low in both reservoirs during this phase, although the diversity of food resources remains quite high. Isolated fragments of bison appear only in the Granger Reservoir assemblages. As in the preceding phase, floral resources continue to be exploited in both reservoirs. Ground stone tools appear in the assemblages of both reservoirs once again.

18.8 Toyah Phase

Chronology

Recognition of components of this phase relies on the presence of Perdiz projectile points and Leon Plain ceramics. Two sites in the North Fork Reservoir, the Hawes Site (41WM56) and the Barker Site (41WM71), yielded these diagnostic elements. Fresno points also were present at the Hawes Site. Since these assemblages were within the plowzone, reliable radiocarbon samples could not be obtained. In the Granger Reservoir, distinctive components of the Toyah Phase are present at the Bigon-Kubala Site (41WM258) and the Loeve-Fox Site (41WM230). Perdiz points and Leon Plain pottery are present in other assemblages, but diagnostic elements of the Austin Phase are often intermixed. A single date of 480 ± 70 B.P. (UGa-2477) was obtained from the Bigon-Kubala Site for this phase. Although the Toyah Phase is usually presented as occurring between 650 and 150 B.P. (Patterson 1977), it is not apparent that the presently recognized remains of this phase in the North Fork and Granger Reservoir Districts span this entire period.

Artifact Assemblages

The artifact assemblages of this phase are extremely limited. A total of eight tools from site 41WM230 and seventeen from site 41WM258 comprise the entire sample from the Granger Reservoir. A few recognizable diagnostic elements from the Hawes Site (41WM56) and the artifacts from the previously investigated Barker Site (41WM71) (Sorrow 1970;14-17) form the data base from the North Fork Reservoir.

The ceramics from the two reservoir districts are very similar since most sherds resemble the Leon Plain ceramic type which is thought to be indigenous to Central Texas (Suhm and Jelks 1962). The North Fork assemblages, however, contain another ceramic type which exhibits construction and decorative techniques which may have been introduced through contact with areas to the southeast. Meanwhile, the sandy paste ceramics which had appeared earlier in the Twin Sisters components of the Granger Reservoir also appear infrequently during the Toyah Phase.

Settlement/Subsistence Patterns

The densities of lithic debitage and tools from the assemblages of

both reservoirs (Tables 16.9-2, 17.9-2) indicate that the Granger Reservoir was more intensively occupied during this period. Although occupation of a given site may have remained ephemeral, such occupations were recurrent. The variety of faunal resources utilized, including the increased exploitation of bison, suggests that the sites of the Granger Reservoir continued to function as generalized foraging camps. The high proportion of scrapers from the Barker Site (Sorrow 1970:9-11) in the North Fork Reservoir indicate a more specialized function for that particular site. The limited nature of the assemblages in the North Fork Reservoir suggest that such components merely represent brief hunting forays into the area or rest stops on the way through the drainage. Only the Granger Reservoir appears to have had a resident population during the Toyah Phase.

VIII. CONTRIBUTIONS TO CENTRAL TEXAS ARCHAEOLOGY

19.0 Models of Prehistoric Adaptation in the San Gabriel River Valley

by

Duane E. Peter and T. R. Hays

19.1 Introduction

The distinctive environmental setting of the North Fork and Granger Reservoir Districts provides an excellent laboratory for the evaluation of models concerning prehistoric adaptations in the San Gabriel River Valley. The location of the North Fork Reservoir at the periphery of the Edwards Plateau and the Granger Reservoir within the Blackland Prairie region of the Coastal Plain permits the sampling of adaptations to two different environmental zones. Although the San Gabriel River Valley has long been regarded as part of the Central Texas culture area (Suhm, Krieger, Jelks 1954), it is possible that the differing biotic zones necessitated differing adaptations which resulted in cultural boundaries which are yet to be recognized. On the other hand, the nature of the Blackland Prairie uplands and the Edwards Plateau uplands may have been sufficiently uninviting that adaptations focused on the river corridor rather than on the biotic zones as a whole.

A regional perspective concerning the prehistoric utilization of the San Gabriel River Valley has been discussed previously by Shafer and Bryant (1976) and Moore, Shafer, and Weed (1978). Eddy (1973) and Prewitt (1976) also have proposed settlement models for the San Gabriel River Valley although their models relate only to the determinants of specific site locations rather than to a broader settlement-subsistence system. Although the factors affecting site location are important, the primary objective of this discussion will be the delineation of the prehistoric adaptations to the two biotic zones and their interrelationships.

19.2 Previous Models

On the basis of survey data and limited testing information, Shafer and Bryant (1976) proposed two alternative models concerning the prehistoric utilization of the San Gabriel River Valley. The first model, the "Prairie Centered Adaptation", places the Granger Reservoir District at the center of a larger territorial domain. The model proposes that the prairie inhabitants ranged up and down the river corridors onto the plateau and into the post oak savanna to the east in order to exploit the greatest diversity of resources available

for this area of Central Texas. This model rests on the assumption that no single zone could provide the resources necessary to sustain a foraging population throughout the yearly subsistence cycle (Moore, Shafer, Weed 1978: 72-77). The validity of this underlying assumption and the model will be critically evaluated later.

The alternative model proposed by Bryant and Shafer recognizes the prairie as an ecotone between adaptations to the Edwards Plateau and the Post Oak Savanna, respectively. This "Prairie Ecotone Adaptation" should be reflected by prairie sites yielding a mixture of elements from the two cultural zones. Due to their assumption concerning the carrying capacity of these respective biotic zones, this model is considered least plausible by its proponents (Moore, Shafer, and Weed 1978: 75). Perhaps, the least plausible aspect of this model is that the prairie zone would be a zone of territorial contention between the two populations. Unless the prairie zone was extremely productive at a given point in time, it would not have offered any greater variety or abundance of resources than the adjacent biotic zones. The concept that the area served as a contact point of East Texas Coastal Plain adaptations and Edwards Plateau adaptations is not unwarranted, however.

As pointed out by Moore, Shafer, and Weed (1978: 75), the testing of these models requires a large set of well documented archaeological data. The recent excavation and testing of archaeological sites in the two reservoir districts has provided a well documented data set for examining the relationships between the two areas. Although these excavation efforts were not always successful in attaining adequate samples for each of the several occupational phases recognized for Central Texas, the above models must be evaluated in light of the available data. Examination of the interreservoir relationships hopefully will provide a basis for the refinement of these models or the proposal of more suitable models. It is possible that a single model of prehistoric adaptation to this region is not viable for all of the recognized occupational phases of Central Texas prehistory.

19.3 Discussion

The similarities and differences in the artifact assemblages and settlement/subsistence patterns of the sites from the two reservoirs have been presented in earlier sections (Chapters 16.0-18.0). Only those elements pertinent to the evaluation of these models will be discussed in any detail in this section. As Moore, Shafer, and Weed (1978: 75) note, an examination of the stylistically sensitive elements (projectile point types) of the two reservoir districts can provide data relevant to an assessment of the continuity or discontinuity of geographic patterning between the two biotic zones. Inter-zonal movement may be revealed through an examination of feature type distributions which may or may not be zone specific. The distribution analysis of artifacts made from raw materials such as granite, vein

quartz, quartzite, and sandstone, which were most likely procured from outside the San Gabriel River drainage, can provide additional information concerning the inter-zonal movement.

Examination of the projectile point styles from the respective reservoir districts reveals only two periods when there appears to be a discontinuity between the Blackland Prairie and Edwards Plateau regions. These two periods involve the San Geronimo and Clear Fork Phases. During the San Geronimo Phase (5,000-7,000 B.P.), the greater representation of projectile point types (Hoxie and Group 9) within the Granger Reservoir, the intra-type variability of the projectile points, and the intra-class variability of the other tools between the two reservoirs is notable. During the following Clear Fork Phase, the stylistic differences of the projectile points become even more pronounced, for the specimens from the Granger Reservoir share morphological characteristics with specimens from assemblages found east of the Balcones Escarpment in the prairie region. Dawson points and previously undefined Groups 1, 2, 4, and 7 are present in the Granger Reservoir, but are minimally represented in the North Fork drainage. Oddly enough, the stylistic variability of the other tool classes declined during this same phase.

Although it is very difficult to assign a particular meaning to this pattern during the San Geronimo and Clear Fork Phases, there was apparently some boundary relating to stylistic expression between the two regions. If one assumes that such stylistic differences may represent different groups of people, then distinctive groups of people may have been adapting to the Blackland Prairie and Edwards Plateau regions, respectively. Some level of interaction of the predominant point styles of each reservoir in the other. Whatever the significance of this patterning, it is apparent that a discontinuity exists between the Blackland Prairie and the Edwards Plateau regions.

This discontinuity, especially in the Clear Fork Phase, suggests that the "Prairie Centered Adaptation" model (Moore, Shafer, and Weed 1978) is not appropriate. Although some level of interaction between the groups exploiting the two biotic zones is indicated, there is no evidence that the subsistence level of the inhabitants of the Granger Reservoir District was partially dependent upon the exploitation of the Edwards Plateau region. The resources of the riverine corridor together with the resources of the upland prairie (bison and pronghorn antelope) could have provided a sufficient resource base within the prairie region alone. Whether the inhabitants of the Blackland Prairie region also utilized the Post Oak Savanna to the east remains a moot point, for very little excavation has been conducted in that region.

The stylistic homogeneity of the occupations of the two biotic zones during the remaining phases of occupation superficially indicates a homogeneous exploitative population. This view, however, is overly

simplistic and cannot be used in support of or in rejection of the "Prairie Centered Adaptation" model. Although the data base from the Circleville Phase is too meager for an evaluation of the models, the remaining occupational sequence from the Round Rock to the Toyah Phase can be used. The distribution of feature types and raw materials and the settlement/subsistence patterns of the two reservoir districts will be reviewed for this evaluation.

During the latter portion of the Clear Fork Phase, occupational intensity increased significantly in the North Fork Reservoir (Table 16.9-2). The accumulation of masses of burned rock was initiated and resource exploitation diversified even more to include the available floral resources, especially acorns. Pecked and ground stone artifacts also became a significant portion of the tool assemblage. The raw materials for these artifacts probably were procured from the Colorado River Basin and the Llano Uplift region. This pattern remains much the same through the end of the San Marcos Phase. In the Granger Reservoir District, however, the pattern is much different. Although occupational intensity was high at a limited number of sites during the Clear Fork Phase, it appears to have declined dramatically during the Round Rock Phase. Although burned rock accumulations were produced in the Granger Reservoir sites during this period, they are significantly smaller and different in structure. Basin-shaped hearths are common, but none are deep like the pit hearths or ovens that appear at the base of the middens in the North Fork Reservoir. The expolitation of floral resources and the resulting need for ground stone tools were not an important segment of the subsistence strategy in the Granger Reservoir.

Although the reasons are not clear, the Blackland Prairie region of the San Gabriel River Valley was not a favored location during the Round Rock Phase. The adaptation to the San Gabriel River Valley clearly centered on the Edwards Plateau region. The availability of a diverse array of faunal and floral resources apparently caused sites to be reoccupied repeatedly. Whether the Granger Reservoir District was an ecotonal area between the Edwards Plateau region and the Post Oak Savanna to the east is largely conjectural. Given the low level of occupation, it is highly unlikely that the inhabitants of either region viewed the Blackland Prairie as a necessary part of their subsistence cycle.

During the latter portion of the San Marcos Phase, the utilization of the Granger Reservoir District changed significantly. Deep basin-shaped hearths, or ovens, appear for the first time. A massive accumulation of burned rock was initiated at the Bryan Fox Site (41WM124) and continued to grow during the Twin Sisters Phase. The subsistence economy also became more diversified with an increased reliance on floral resources. The presence of bison remains in many of the assemblages of the Granger Reservoir during the San Marcos Phase (Table 15.7-E) indicates that bison herds frequented the

Blackland Prairie during this period and may have been a drawing factor in the increased habitation of the Granger Reservoir District. The appearance of the complex of traits related to the exploitation of floral resources, the deep earth oven and the associated accumulation of burned rock during this same time period probably was not coincidental.

Interestingly, the frequencies of debitage types from the sites of the respective reservoir districts are also very similar during this period (Chapter 14.4). The inhabitants of the North Fork drainage, who had opportunistically procured bison when they were available during the preceding Round Rock and Clear Fork Phases, may have ventured downstream into the Blackland Prairie region when that food resource was available. Although the shift toward a prairie centered adaptation had probably started, the focus of the adaptation was still in the Edwards Plateau. The recovery of a conch shell bead and a Marginella shell from the San Marcos component of the Loeve-Fox Site, however, also denotes contact (perhaps indirect trade) with the Gulf Coast area. Whether the occupants of the Granger Reservoir area ventured to the southeast as a part of their subsistence cycle is unknown, but unlikely.

By the middle of the Twin Sisters Phase, the shift to a "Prairie Centered Adaptation" is indicated by a decline in settlement of the North Fork drainage which continued through the later Austin and Toyah Phases. Occupation of the Granger Reservoir District never becomes very intensive, but the region was apparently favored over the Edwards Plateau. Interestingly the deep earth ovens remain a characteristic trait of the Blackland Prairie region, but are no longer found in the North Fork components. Although bison remains are not overly abundant in the Granger Reservoir assemblages during the remainder of the prehistoric occupational sequence, bison apparently were available at infrequent intervals. Even during the Toyah Phase when prairie resources were exploited more intensively, the local exploitation of bison does not appear to be very high.

The high proportion of small mammals in the faunal assemblages of the Granger Reservoir sites during this occupation span suggests that the subsistence level may have been marginal during some periods. Exploitation of the bordering environmental zones may have been included in the seasonal cycle. The minimal presence of sandy paste ceramics during this period suggests interaction with groups to the southeast, while the raw materials for the ground stone tools (quartz, quartzite, and sandstone) indicate access to the Colorado River Basin or the Llano Uplift region. The necessity of the occupants of the Blackland Prairie region to actually include the Edwards Plateau region and the Post Oak Savanna in their seasonal round has not been demonstrated, however. Present evidence merely indicates that some level of access was available to the bordering regions of the Blackland Prairie.

19.4 Summary

From the above discussion it is apparent that a data base of broader geographical scope and finer analytical detail is needed for a proper evaluation of the previously proposed adaptive models. The limited archaeological investigations in the Blackland Prairie region, itself, and in the Post Oak Savanna to the east allow only general observations concerning the interrelationships of the two areas. The general stylistic comparisons of the projectile points probably mask inter-areal variability within particular types. Intra-type analysis, as proposed in Chapter 14.1, is necessary if the areal variability within such widespread diagnostic elements is to be delineated. Although the significance of that patterning will not be any more easily understood, the patterning itself can provide clues to the levels of interaction among different areas.

Based on the present data, evaluation of the "Prairie Ecotone Adaptation" is quite difficult. The general lack of knowledge concerning the Post Oak Savanna zone to the east makes any judgements concerning the nature of the Granger Reservoir assemblages quite tentative. Nevertheless, the available evidence from the Lake Limestone area (Mallouf 1977) exhibits no strong similarities with the Granger Reservoir assemblages throughout much of the Archaic period. Only during the Austin and Toyah Phases are there stylistic similarities among the diagnostic elements. These similarities, however, are not particularly significant due to the widespread distribution of these styles throughout Central Texas. The appearance of coastal shells and sandy paste ceramics in the Granger Reservoir assemblages at various times after 1750 B.P. denote contact with groups to the south and east, although it is unlikely that the subsistence cycle of the occupants of the Granger Reservoir District included these areas. At the same time the stylistic similarities with the Edwards Plateau region are notable. Raw materials for ground stone artifacts are acquired from the west, also. That the Blackland Prairie region served as a contact point for the East Texas Coastal Plain and Edwards Plateau adaptations is apparent. Unfortunately, the level of interaction and type of movement between these zones is not.

The "Prairie Centered Adaptation" model as presented by Moore, Shafer, and Weed (1978) postulates that movement between the three zones was necessary to provide the necessary diversity of resources to sustain hunter-gatherer groups through their yearly subsistence cycle. The archaeological assemblages from both the North Fork and Granger Reservoir Districts reflect the exploitation of a very diversified faunal and floral resource base throughout the occupational sequence. Admittedly, the exploitation of floral resources is greater in the Edwards Plateau region; however, the greater availability of prairie fauna in the Blackland Prairie compensates for the less productive floral exploitation

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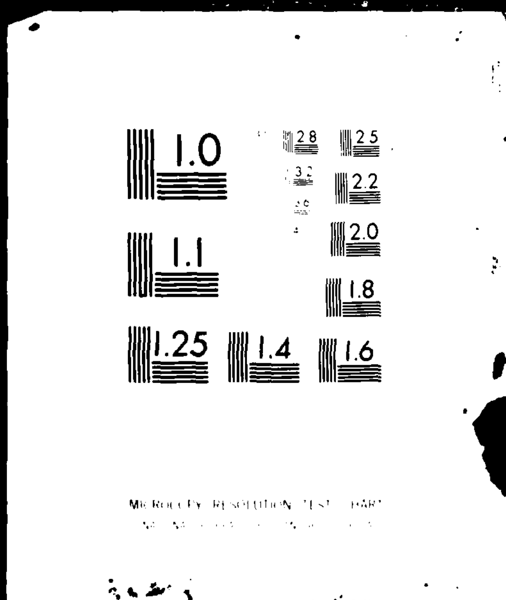

there. From the analysis of the vertebrate (Chapter 8.5) and invertebrate fauna (Chapter 8.6), it is apparent that an extensive gallery forest was present within the San Gabriel River Valley as it flowed through the Blackland Prairie. This gallery forest together with the prairie uplands provided a very productive and diversified resource base. In fact, it was only during those periods when the gallery forest may have given way to a more open bottomland environment (Round Rock and early San Marcos Phases) that occupation of the Granger Reservoir District declined significantly.

19.5 Conclusions

The evidence from the archaeological assemblages together with recent observations concerning the nature of modern hunter-gatherer adaptations (Lee 1968; Birdsell 1968; Damas 1969; Deevey 1968; Wobst 1974; Gould 1980) indicate that it was theoretically possible that separate adaptations to the Blackland Prairie and the periphery of the Edwards Plateau could have existed. As Jochim (1976: 65-66) states, population density and distribution are not strictly determined by the environment, but rather they represent adjustments to the environment through the choice of the population. Jochim (1976: 66) further notes that an important contrast exists between the actual carrying capacity of a region and the carrying capacity as culturally defined. Hunter-gatherer populations, even in less than optimal environments, use only a small portion of the available food resources (Lee 1968). Therefore, a successful adaptation is one whose viability is guaranteed during periods of stress rather than optimal resource availability. The density and availability of certain resources in the North Fork drainage may have allowed a greater population density than that of the Granger Reservoir District. Nevertheless, a smaller population could have effectively survived through the exploitation of the river corridor of the Blackland Prairie region, alone. At times, a true "Prairie Centered Adaptation" may have functioned during several of the occupational phases of the San Gabriel River Valley.

As noted above, finer analytical detail must be directed toward this problem, if the interrelationships between the populations using the respective reservoir districts are to be recognized. Nevertheless, generalized hypotheses concerning such relationships may be offered for consideration. Admittedly, sampling problems associated with the San Gabriel assemblages may have biased these observations. Too frequently, a very limited number of components of a particular phase were sampled. In light of the available data, however, the following dynamic model of the prehistoric adaptation to the San Gabriel River Valley is presented for consideration. This model recognizes the flexibility of hunter-gatherer adaptations and the dynamics of a human ecological system. No single static model can possibly characterize over 8,000 years of prehistoric occupation. Whether this model is representative of the larger

Edwards Plateau/Blackland Prairie ecotonal situation remains to be determined. This model hopefully will serve as a stimulus for future research efforts along the Balcones Escarpment.

During the Circleville Phase population density was very low and territorial ranges were probably quite large and frequently overlapping. It is unlikely that the Balcones Escarpment served as a territorial boundary. During the following San Geromino Phase, however, the stylistic differences of the assemblages of the respective reservoirs denote the beginnings of a polarization of the adaptations to the Edwards Plateau and Blackland Prairie environments. In fact, the North Fork drainage may have served as a contact area between a central Edwards Plateau adaptation and a prairie adaptation.

The polarization of these adaptations appears to be strongest during the Clear Fork Phase. The assemblages of the North Fork Reservoir exhibit great affinity to the rest of the Plateau region. The characteristic Plateau adaptation, as represented by the ubiquitous burned rock middens, is initiated during this period and persists through the San Marcos Phase. In the Granger Reservoir, assemblages of the Clear Fork Phase contain characteristics recognized in other Blackland Prairie assemblages (Duffield 1963; Prewitt 1974). The Blackland Prairie region may not have offered the variety and density of resources that the Plateau region did, but an adaptation distinctive to the prairie zone apparently thrived anyway.

The intensity of the prairie adaptation appears to decline significantly during the Round Rock and early San Marcos Phases. Apparently, the riverine corridor was not productive enough during this time span to support a larger population within the Blackland Prairie. The adaptation of the upper San Gabriel River Valley is clearly focused on the Edwards Plateau region during this period. During the latter portion of the San Marcos Phase a complex of traits appear within the Granger Reservoir District which suggests a downstream extension of the Edwards Plateau adaptation.

The remainder of the occupational sequence of the upper San Gabriel River Valley is characterized by a definite shift to a prairie adaptation. Occupation of the North Fork drainage declines significantly while occupation of the Blackland Prairie remains fairly stable. The overall carrying capacity of the entire drainage appears to have been negatively affected, however. Utilization of both the periphery of the Edwards Plateau and the Blackland Prairie may have been necessary to sustain a foraging population. Nevertheless, the prairie region became the focal point of activity during the Austin and Toyah Phases (cf. Patterson and Shafer 1980:102).

20.0 Alternative Perspectives on Burned Rock Middens

by

Duane E. Peter

20.1 Introduction

Any archaeologist conducting research in the Edwards Plateau region is faced with the continuing enigma of the burned rock middens. Although there is a general consensus that the massive accumulations of fire-cracked rock and associated artifacts are the result of food processing activities, the particular foods processed and the site formation processes contributing to such accumulations have not been well documented. Although over one hundred burned rock middens have been investigated in Central Texas since Pearce's (1919) initial investigations, the particular food resource requiring the use of massive quantities of burned rock for its processing remains a matter of speculation rather than documented fact. Factors such as a lack of good floral and faunal preservation in many Central Texas sites, methodological inadequacies in recognizing isolated features in the massive accumulations of burned rock, and a culture-historical perspective that has focused on the content of the mound of burned rock rather than its relationship to the remainder of the site have contributed to this lack of understanding.

Although a culture-historical perspective guided the NTSU research in the North Fork and Granger Reservoir Districts, an awareness of previous attempts to understand burned rock middens focused the research effort towards a determination of intra-site and inter-site variability to better understand the accumulation processes of burned rock middens. Excavation and sampling methodologies were designed to aid in the recognition of isolated features, the collection of all available floral and faunal remains, and the delineation of distinct activity areas within the sites. Although these efforts did not provide conclusive answers to all of the questions concerning burned rock middens, data pe[illegible]t to the evaluation of the current hypotheses regarding the forma[illegible]ocesses involved and the food resources being processed were obtained. [illegible]efore, the following discussion will include an evaluation of the prevalent hypotheses, a summary of the pertinent San Gabriel data, and recommendations for future investigations of burned rock midden sites.

20.2 Current Models Concerning Burned Rock Middens

The variability, both from a synchronic and a diachronic perspective, of burned rock middens within Central Texas is quite great. As

Hester (1971:123-127) has succinctly noted, many of the accumulations of burned rock include numerous lithic and bone artifacts while others contain very few associated artifacts. These sites also vary structually. The classic dome-shaped midden is most common in Central Texas, although ring middens and general burned rock scatters have been recorded (Collins 1973; Shafer 1975). Crescent and ring-shaped middens also are very common in west Central and Southwest Texas during the late prehistoric period. Weir (1976), in an attempt to synthesize the Archaic period of Central Texas prehistory, categorizes this variability into four types:

(a) Type 1 - oval and mounded in shape; most common type in Central Texas; appears at end of San Geronimo Phase, most common during Clear Fork and Round Rock Phases, and decline with beginning of San Marcos Phase.

(b) Type 2 - occurs primarily in western and northwestern part of Central Texas; circular aggregation of burned rock around a central pit; usually barren of artifacts, but charred plant remains often found; occurs late in the Archaic period; examples in Central Texas during late Clear Fork or early Round Rock Phases (Weir 1967; Collins 1973), but are at variance with definition; both contain abundant artifact remains.

(c) Type 3 - occurs on western periphery of Central Texas and westward into the Southwest; known as "midden circles" or ring and crescent middens; slab-lined, subsurface pits surrounded by aggregation of burned rock; charred plant remains often found; appears during San Marcos Phase and lasts into historic times farther to the west (Greer 1965, 1968; Opler 1941).

(d) Type 4 - burned rock accumulations or scatters; usually no thicker than one layer of burned rock; may represent scattered hearths or may be incipient to other middens; occurs throughout Archaic period.

Since the investigations of the North Fork and Granger Reservoir Districts revealed only two of these midden types (Types 1 and 4) the following discussion will be restricted to those types. The term, "burned rock midden", will be used to refer to those sites exhibiting a classic, dome-shaped mound. All other sites within the Granger and North Fork Reservoir Districts will be referred to as "burned rock accumulations." The term "mound" in this discussion will serve only as a reference to the configuration of certain masses of burned rock.

An historical overview of the numerous investigations of burned rock middens will not be attempted here; rather the reader is referred to Prewitt's (1976) review of the available literature and numerous unpublished manuscripts. The present discussion will focus on perspectives concerning the formation processes and functions of

burned rock middens. Prewitt (1976) summarizes the several perspectives by presenting four alternative hypotheses which have been used to explain the formation of burned rock middens. These hypotheses are: (1) the intersecting hearth hypothesis; (2) the community dump hypothesis; (3) the rock oven hypothesis; and (4) the rock slab hypothesis. Although these hypotheses are presented as alternatives for the delineation of the accumulation processes of burned rock middens, the utilization of heated limestone slabs or cobbles as either a griddle or a retainer of heat or as a source of heat for an earth oven is central to all four hypotheses. There is an apparent agreement among researchers that a considerable amount of cooking was being done. A concensus concerning the particular food resource being cooked and the disposal patterns associated with the cooking process has yet to be reached.

The four hypotheses, as presented by Prewitt (1976), represent the intermingling of several ideas concerning site formation processes and resource utilization. As recognized by Hester (1971) the variability exhibited by burned rock midden sites will not be readily subsumed under a single explanatory scheme. For the sake of clarity, however, the following discussion of the prevalent hypotheses will first focus on site formation processes and then on the resource utilization represented by these sites.

Two major viewpoints have been postulated concerning the site formation processes responsible for such massive accumulations of burned rock. The first viewpoint recognizes that the accumulations of rock "grew by accretion incident to occupation" (Kelley and Campbell 1942: 319). In other words, the accumulation of burned rock and artifacts is the result of repeated occupations of a favored locality. Such occupations involved the repeated use of small basin shaped, stone-lined hearths. Kelley and Campbell (1942: 320) represent the process in the following manner:

> Familiarity with these methods of hearth construction makes it easier to understand the jumbled and more or less homogeneous appearance of a mound in cross-section. Prolonged or repeated heating caused the hearth stones to break up into many angular fragments. The hearths were then cleared of old stones and relined, or else abandoned. Later, other hearths were built in the same area, the result being a complex assemblage of superimposed and intersecting hearths. This element of human disturbance is of course an important factor to consider in connection with the problem of cultural stratigraphy.

Pearce (1919:230) had earlier stated a similar position by emphasizing the "kitchen midden" character of the mounds of Central Texas. Huskey

(1935:105) similarly viewed the accumulation of burned rock as a result of the repeated use of rock-lined hearths. Huskey interpreted the mound as the center of activity for recurrent occupations of a favored locale.

Kelley and Campbell (1942:321-322) further noted that the middens of the Colorado River Valley were located in a single physiographic situation -- that of the upper terrace where a relatively stable surface had existed for long periods of time. Elsewhere in the valley the rapid accumulation of silts precluded the formation of such massive accumulations of burned rock. Unfortunately, except for Suhm's (1959) later examination of the Williams Site, this observation concerning the varying depositional regimes of sites within Central Texas has been largely ignored. Suhm's investigation of the Williams Site led to the conclusion that the occurrence of burned rock middens is "dependent upon: (1) the abundance of native stone, especially limestone, (2) the extensive use of stone-lined and/or stone-encircled hearths, (3) repeated use of favored camping localities, and (4) slow deposition of alluvium" (Suhm 1959:247).

The above view, popularly but somewhat erroneously referred to as the "intersecting hearth" hypothesis, continued to be the generally accepted view of the site formation processes of burned rock middens until further investigations (Sorrow 1969; Hester 1970, 1971) revealed site situations exhibiting evidence of other processes. Sorrow's (1969) investigation of the John Ischy Site (41WM49) led him to propose that burned rock middens may be specific "dump" areas or "cooking" areas adjacent to the actual living area. The lack of any recognizable hearths within the accumulation of burned rock at the John Ischy Site and the association of isolated hearths with a jumbled pile of burned rock fragments at the Evoe Terrace Site (Sorrow, Shafer and Ross 1967) led Sorrow to prefer the "community dump" hypothesis, but he did not rule out the possibility that the midden may have served as a specialized cooking area. It is apparent, however, that the central living area of the John Ischy Site was adjacent to the burned rock mound. Later investigations in Uvalde County led Hester (1970, 1971) to propose that although the previous evaluations of the accumulation processes of burned rock middens might fit some burned rock middens, the dumping of unusable hearthstones in a specified area might better explain those accumulations at other sites with few associated artifacts.

Intertwined with the continuing thought concerning the nature of the accumulation processes was the speculation concerning the foods being processed which would require so much burned rock. Interestingly, most of the earlier discussions (Pearce 1919; Huskey 1935; Kelley and Campbell 1942, Suhm 1959) concerning burned rock middens dealt with this matter only indirectly or in a very matter-of-fact manner. The hearth stones were recognized as being used to "keep the fire together and for cooking and boiling water" (Pearce 1919:230) and for roasting chunks of meat (Huskey 1935:105). Part of the reason for the earlier lack of attention to this issue was the lack of preservation of faunal

and floral remains in many of the Central Texas sites. Researchers were also aware of the presence of stone-lined hearths in other areas of North America and probably did not view them as functioning differently in Central Texas.

Only Wilson (1930), who was primarily interested in southwest Central Texas, sought to relate the distribution of burned rock middens to the distribution of a particular food resource (sotol). This was the first instance where ethnohistoric examples were used to explain the function of burned rock middens. Unfortunately, the use of ethnographic analogy to explain the function of specialized and perhaps restricted (spatially and temporally) variants of the burned rock midden has perhaps biased researchers' judgements of the function of other earlier variants. Nevertheless, as research has progressed, the burned rock middens have become more special in researchers' minds. Although researchers were aware that burned rock accumulations and stone-lined hearths do appear elsewhere in the world, they were also intrigued by the limited distribution of these unique forms in Central Texas. Because of their relatively unique traits, burned rock middens are often thought to represent a specialized adaptation. Of course the ethnohistoric examples point readily to their function as plant processing stations. Due to these factors, a third hypothesis concerning the formation of burned rock middens has been implicit for some time: the mounds of burned rock represent the repeated utilization of favored locales for the cooking or processing of a floral food resource in earth ovens.

This perspective has guided and perhaps biased research efforts in Central Texas for some time. The recognition of "possible" ring middens during the Clear Fork and Round Rock Phases at Devil's Hollow (Collins 1973) and at Greenhaw (Weir 1967) strengthened the notion that the use of earth ovens for plant processing might have been one of the functions of burned rock middens in Central Texas. Sorrow (1969), although preferring the "community dump" hypothesis, also recognized the possibility that the middens may represent a specialized resource adaptation. Although Sorrow (1969:51) avoided any inference concerning the food resource processed in the "cooking area," he stongly implied that a vegetable food resource is most likely through this statement: "Pollen analysis and flotation of the fill of hearth or cooking areas (whether off the rock accumulation or a part of it) should suggest what was cooked."

It was not until 1973 that a particular food resource, other than sotol was suggested for consideration. Hester (1973), citing ethnographic examples of California Indians who specialized in acorn processing and who also produced burned rock accumulations, suggested that acorn processing may be an important factor to consider. Weir (1976), in an attempt to provide a synthesis of Central Texas, expanded upon this suggestion considerably. Weir (1976:125-126) proposed that the Clear Fork and Round Rock Phases represent a specialized adaptation in which the harvesting of the fall mast crop (acorns) is a focal endeavor.

Weir characterized the economy as focal (Cleland 1966) in nature with the Type 1 burned rock middens developing as a result of specialized nut processing. Creel (1978:241-307), through an examination of the spatial relationships between burned rock middens and the hypothesized prehistoric microenvironments in the South Concho River Valley, suggests that burned rock middens are associated with the exploitation of mast crops as proposed by Weir (1976). Unfortunately, neither researcher explicitly discussed the particular need for so much rock for the processing of acorns. Furthermore, Weir's (1976) data base consisted primarily of sites dug before matrix flotation became a standard field procedure and Creel's (1978) was based solely upon survey data; consequently, neither hypothesis was supported by the actual recovery of floral remains.

During this same time period, alternative ideas concerning the food resource being processed were presented. As a result of a study of the distribution of sites and associated assemblages along Turtle Creek in Kerr County, Skinner (1974) proposed that burned rock middens with few artifacts served as ovens for cooking large mammals such as deer or bison and were incidentally trash heaps. Although such a hypothesis must be considered, the evidence from the Kerr County sites did not allow the testing of this hypothesis. This hypothesis, although restricted to a particular variant of the burned rock middens, at least recognizes that earth ovens may be used to cook faunal as well as floral food resources.

Prewitt (1976) in his historical review of archaeological interpretations of burned rock middens proposed a variation of the earlier hypothesis concerning the processing of sotol (Wilson 1930). Prewitt speculated that sotol had been present near the Balcones Escarpment during the Clear Fork and Round Rock Phases and that "with a subsequent mesic trend in the San Marcos Phase, the sotol apparently died out in Central Texas and its range withdrew to the Trans-Pecos region" (Prewitt 1976:108). This hypothesis is indeed interesting, but it is unsubstantiated at this time.

Unfortunatley, all of the above hypotheses concerning the food being processed in the burned rock middens are unsubstantiated. Until recently, the recovery of floral remains and the recognition of features within or adjacent to the middens has been largely unproductive. Research strategies aimed toward chronology building and the mounds themselves rather than their place in a broader settlement/subsistence scheme have been largely responsible for this situation. An excessive, and perhaps dangerous, reliance on ethnographic analogy also has provided a bias to researcher's perspectives. Alternatives to the processing of floral resources should be given more consideration. After all, the use of stone-lined hearths and accumulations of burned rock are known from elsewhere in North America where the processing of sotol or some other floral resource was not the primary factor causing such occurrences. The use of earth ovens or stone griddles for the cooking of meat are certainly viable alternatives which have been

often ignored.

20.3 The San Gabriel Data Base: Its Bearing on the Above Hypotheses

Several of the previous efforts (Sorrow 1969; Hester 1971; Collins 1973) to understand the accumulation processes and function of burned rock middens have noted the types of data required and the research methodologies needed to test the above hypotheses. All of these researchers have commented on the need to excavate large areas of the site, both within the midden proper and outside of it, so that differential activity areas may be recognized. The continued focusing of research efforts on the mounds themselves will not provide the answers we are seeking. Sorrow (1969) and Collins (1973) also noted the need for rigorous recovery techniques which would permit the recognition of isolated features within these sites. Rigorous recovery techniques are also essential to the determination of whether or not there was a particular economic pattern associated with these sites. Palynological and macrobotanical studies should provide indications of resource availability and the variety of floral resources being exploited.

The above considerations guided the research conducted by NTSU at burned rock middens in the North Fork Reservoir District. Although contractual constraints restricted the areal expanse excavated at any one site, a concerted effort was made to investigate areas both within and outside the mounds themselves. The careful removal and mapping of each layer of burned rock within the midden sites was designed to permit the recognition of stratigraphic associations and isolated features. The systematic collection and processing of matrix samples from the northwest quadrant of each arbitrary 10 cm. level of every excavation unit and all features provided for the maximum recovery of available macrobotanical remains (Chapter 15.2). Unfortunately, our attempts to recover pollen from these sites were no more productive than previous attempts (Chapter 15.4). Nevertheless, data concerning the types of features present and their distribution, artifactual distributions, and faunal and floral associations within the burned rock midden sites were collected. These data provide valuable insights into the nature and variability of burned rock middens in the San Gabriel River Valley.

Although all of the sites investigated in the North Fork and Granger Reservoir Districts contributed to the overall perspective of the settlement/subsistence strategies utilized through time, the investigations of sites 41WM53, 41WM56, 41WM57, 41WM73, 41WM304, and 41WM124 were particularly pertinent to an understanding of the formation processes and functions of burned rock middens or accumulations. The investigation of these sites and the prior investigation of the John Ischy Site (Sorrow 1969) revealed a significant amount of variability among the burned rock accumulations within the two reservoir districts. Burned rock middens (Weir's Type 1) were present at all of these sites except sites 41WM53 and 41WM56. Burned rock accumulations (Weir's Type 4)

were present at the latter two sites. Smaller burned rock middens also are present along the upland drainages and on the upland itself. Unfortunately, very little information is available concerning these sites for none has been investigated.

At those sites containing mounds, only site 41WM73 does not exhibit an extensive living area peripheral to the mound itself. At site 41WM73 the mound of burned rock was the focal point of intensive and perhaps functionally specific utilization for most of the Archaic period. During the Round Rock and San Marcos Phases (the major periods of burned rock accumulation), tool densities do not vary significantly across the midden and its periphery. Interestingly, at none of the recently investigated sites do the tool densities vary significantly between the mounds and the adjacent areas (Table 20.3-1). At site 41WM57, only Area H exhibits significantly higher densities of tools. Other than Area I, which must be discounted due to deflation, Areas F and H are the only areas totally outside the accumulation of burned rock at Site 41WM57. Area H has extremely high tool density values while Area F has low density values. Elsewhere in the site density values are very consistent. At Site 41WM304, there is a density difference within the mound itself (Table 20.3-1). Unfortunately, the significance of this difference is unclear due to the large portion of the site which was removed by borrow pit activities. Nonetheless, other than the John Ischy Site and possibly Site 41WM304, the mounds of the recently investigated sites are not distinguished by significantly lower tool densities. Debitage density values are variable but they do not show any particular pattern among the sites (Table 20.3-1).

Perhaps more noteworthy are the structural differences exhibited by the features within these sites. At site 41WM57, deep basin-shaped hearths were observed only within the mounds proper while less formal hearths (circular clusters of burned rock) were discovered either beneath the midden zone or at the periphery of the burned rock accumulation. At site 41WM73 a deep hearth or earth oven also was found at the base of the burned rock midden. No isolated hearths were recognized elsewhere in the burned rock accumulation. Basin-shaped hearths also were noted at the base of the midden at site 41WM304. Whether these basin-shaped hearths served a function specific to that of the mound of burned rock is not clear, however. At sites 41WM53 and 41WM56 where no mounds occur, basin-shaped hearths also appear although they are not nearly as deep as those from sites 41WM57 and 41WM73. It is possible that the deeper hearths did serve a different function from those elsewhere, although that difference is not easily inferred from the available data.

Excavation of sites 41WM53 and 41WM57 yielded important information concerning the formation of burned rock middens. The careful excavation and recording of the mass of burned rock, especially in areas where the accumulation was not so massive as at site 41WM73 or within the mounds themselves, revealed that the mass was the result of the accumulation and superpositioning of numerous hearths and their

Table 20.3-1. Tool and debitage densities of components exhibiting burned rock midden accumulations within the North Fork Reservoir. See Table 16.9-2 for density values of the Hawes Site (41WM56).

Site	Component	Excavation Area	Excavated Volume m^3	Tool Density N/m^3	Debitage Density N/m^3
Site 41WM53	Austin/Twin Sisters	A*	2.0	48	2650
		B	1.4	54	1309
Site 41WM57	San Marcos/ Round Rock	A	3.3	33	2842
		B*	1.2	43	2509
		D*	2.5	31	1222
		F	1.5	9	835
		G	1.6	16	1663
		H	.9	71	3724
		I	1.2	52	6580
	Round Rock	E*	2.6	31	1533
Site 41W[illegible]3	San Marcos	A	1.0	26	2807
		E	.2	20	650
	Round Rock	A	.9	16	1858
		B*	5.0	22	931
		C	1.4	34	2098
		D	.4	18	988
		E	1.0	13	993
Site 41WM304	Round Rock	A	2.4	23	1828
	Clear Fork	A	1.2	47	5493
		B*	2.7	28	2356

* Mound or dense burned rock midden areas.

associated debris through time. The continued scattering of the fire-cracked rock between the hearth areas would eventually produce a homogeneous matrix of soil and fire cracked rock. Such a process would not necessarily produce a dome-shaped structure unless a specialized activity was recurrent at that location. The repeated construction and utilization of deep hearths or ovens at specified locales over hundreds of years could produce the structureless jumble that is evident at sites 41WM57, 41WM73, and 41WM304.

The existence of the mounds themselves at certain sites and not at others during a given time interval suggests that they represent some specialized function other than that of a dump heap. A seemingly plausible hypothesis is that they represent seasonally specific utilizations of the immediate area. A comparison of sites 41WM56, 41WM57, and 41WM73 during the Clear Fork and Round Rock Phases indicates that those sites with mounds contain either a much less diverse faunal assemblage or a greater emphasis on the exploitation of smaller mammals than site 41WM56 does. This pattern may suggest that the occupants of sites 41WM57 and 41WM73 were focusing their efforts on some activity other than the processing of the available fauna.

As suggested by previous investigators (Hester 1973; Weir 1976; Creel 1978), the processing of acorns is a seasonally specific task which should be given consideration. The macrobotanical evidence from these sites (Chap. 15.2) suggests that acorns were the most commonly preserved floral resource. In fact, the meager macrobotanical remains from site 41WM57 were almost entirely recovered from Area E within the mound of burned rock. Elsewhere at site 41WM73, the deep earth oven from the base of the midden yielded a number of acorn fragments. The deposition of a burned rock accumulation at site 41WM53 also coincides with the occurrence of acorn remains at the site. Furthermore, the appearance of burned rock middens or accumulations, acorn remains, and a significant quantity of ground stone tools appears to be more than coincidental in both the North Fork and Granger Reservoir Districts.

Would the processing of acorns require the construction of earth ovens and the utilization of thousands of heated rocks as indicated in the San Gabriel sites? Unfortunately, the most ardent proponents of the association between burned rock middens and the fall mast crop (Weir 1976; Creel 1978) failed to address this question. The removal of the tannic acid from the acorn meal by pouring hot water over it (Baumhoff 1963:167) would hardly have required such efforts; however, the storage of the nut crop through the lean winter months may have.

Hilliard (1980:16) notes three reasons for the light roasting or parching of acorns: (1) the roasting process cracks the shells providing easier access to the kernels, (2) roasting stops the process of germination of the white acorn group by eliminating much of the kernel's moisture content, and (3) the process of roasting destroys any insect larvae that may be present within the nut kernels. The latter two reasons are very important for the storage of acorns. Dry storage

alone will not deter germination. Only a constant temperature below 40°F. or above 95°F. or the elimination of moisture through roasting will deter germination. Although the red acorn group does not germinate until much later, roasting is still necessary to control weevil infestation. Unless the acorns are processed three to four weeks after they are collected, the larvae already present within the nuts would bore out of the shell and could do substantial damage to the remainder of the stored nuts. Therefore, roasting of the acorns in an earth oven or on a stone griddle would be essential to an economy dependent upon acorns during the lean winter months.

How dependent the inhabitants of the San Gabriel River Valley were upon the exploitation of the fall mast crop (acorns, walnuts, and pecans) is very difficult to estimate. As in the South Concho River Valley (Creel 1978) the distribution of burned rock middens correlates well with the present distribution of oak trees. As noted in Chapter 3.1 and Appendix A, the Texas red oak (*Quercus texana*) and White shin oak (*Q. sinuata* var. *breviloba*) are presently found on the upland slopes and in the upland drainages. The scrub live oak (*Q. virginiana* var. *fusiformus*) is prevalent on the uplands. The position of the burned rock middens at the base of the upland slopes and within the upland drainages would have allowed easy access to the fall mast crop, if the modern environmental situation is assumed to be representative of the prehistoric situation. Based on the available data, such an assumption appears to be justified. The poor representation of oaks in the Granger Reservoir District today may also reflect the prehistoric situation for although burned rock accumulations were produced and acorns were utilized, the level of intensity of such activities was significantly lower than that of the North Fork drainage.

Interestingly, the distribution of burned rock middens in the San Gabriel River Valley is very likely more closely related to the distribution of another critical resource -- limestone cobbles or slabs. The distribution of burned rock middens is very well correlated with exposures of limestone along the upland slopes and within the upland drainages of the North Fork Reservoir. Within the Granger Reservoir District limestone outcroppings are very infrequent. The major source of cobbles is the stream itself. The few burned rock accumulations in the Granger Reservoir are located adjacent to this source. Because of the mass of this necessary resource, site location would have depended more upon the distance to it than the distance to the nearest stand of nut producing trees. Perhaps, these two factors interacted in determining site location. Nevertheless, the dependency upon acorns for subsistence remains open to question.

The quantity of acorn remains recovered from the sites (Appendix B) does not reflect a necessary dependence upon their exploitation. Unfortunately, preservation factors within these sites may be biasing their representation. At site 41WM73 acorn remains were preserved only in the deep hearth and the more clayey stratum beneath the midden. The variable wet and dry environment of the midden itself may have

destroyed the acorn remains there. Even so, if the inhabitants of the North Fork drainage had developed a focal economy based on the fall mast crop, the preservation of more charred nut remains would be expected.

Another problem with recognizing the relationship between the burned rock middens and a specialized economic pattern is the apparent temporal restriction of these sites in Central Texas. Although the traditional view holds that the accumulations of burned rock declined significantly after 2500 B.P. (Sorrow 1969; Prewitt 1976), the San Gabriel data base suggests that this decline did not take place until approximately 1750 B.P. Nevertheless, as Sorrow (1969:51) has noted, why did this economic pattern abruptly disappear at this time? Sorrow (1969:51) suggests that "a shift in the economic pattern (perhaps due to an environmental change, or to the introduction of a new economic resource, or a technological advancement enabling the population to pursue an economic resource that had previously been largely unobtainable), or a population displacement" may be possible answers. The North Fork data do suggest a decline in the population inhabiting the area following 1750 B.P. In fact, there appears to be a shift to a prairie adaptation and the procurement of bison as one aspect of a diversified economy. The increasing dryness of the Central Texas environment (Bryant and Shafer 1977) also may have affected the productivity of the nut producing trees. The extension of this scenario to the remainder of the Edwards Plateau is not plausible at this time. These observations of the North Fork Reservoir District are merely hypotheses derived from a sometimes limited data base. Until detailed columns of pollen samples and radiocarbon dates can be collected from a number of Central Texas sites and sedimentation rates can be calculated, dimensions such as resource availability and population density will remain a matter of intuition rather than a well documented inference.

The lack of sedimentation rates for the several sites investigated raises another important question concerning the significance of the burned rock middens. Are the locations of burned rock middens limited to geomorphological situations which exhibited relatively stable surfaces for long periods of time? Kelley and Campbell (1942) and Suhm (1959) have previously noted that the occurrence of burned rock middens may be dependent upon geomorphological situations exhibiting very slow depositional regimes. Unfortunately, subsequent investigators have ignored such observations. A comparison of the site situations within the two reservoir districts however, demonstrates that the presence of burned rock middens may be related to the depositional environment of the site situation. In the North Fork Reservoir the burned rock middens are situated at the backs of the higher terraces adjacent to the upland slope or in the upland drainages. The depositional environment of these site situations would have been quite stable or perhaps even tending towards deflation through erosion. In the Granger Reservoir district, accumulations of burned rock have been noted at sites 41WM22, 41WM122, 41WM124, 41WM230, and 41WM267. The Bryan Fox Site

(41WM124) is the only investigated site in which a massive accumulation occurs, and it is the only site situated on a high terrace which would have been relatively unaffected by flood deposition. The other major sites investigated in the Granger Reservoir District occur in the broad floodplain of the San Gabriel River. Overflow deposits would have been frequent at these sites. Consequently, the accumulation of burned rock and other cultural debris would have been interrupted by silt deposits. Admittedly, the upland situation in the Granger Reservoir District would have been much the same as that of the North Fork drainage, but no burned rock middens are present there. The lack of limestone resources and the low level of use of the prairie uplands for habitation sites probably contributed to this absence.

Although the depositional environment of a site does not fully explain the presence of burned rock middens, it is an important factor that has been largely ignored. A comparison of the hearths from sites of both reservoir districts reveals that cooking throughout the prehistoric sequence involved the use of heated rocks as griddles or as sources of heat for earth ovens. Fire-cracked rocks were a by-product of these activities. Both the roasting of meat and the processing of floral resources could be accomplished in these features. These processes did not cease at the end of the San Marcos Phase for the accumulation of burned rock at site 41WM53 was deposited at the end of the Twin Sisters Phase. The utilization of these sites was merely declining. Consequently, the deposition of burned rock slowed significantly. Therefore, the same processes which contributed to the accumulation of burned rock were present both before and after the most intensive period of accumulation. The same activities also were conducted in the Granger Reservoir District, but no middens formed because of the depositional environment. Therefore, the assumption that the presence of the burned rock middens necessarily represents a specialized economic pattern may be faulty.

Nonetheless, an additional subsistence activity was emphasized within the North Fork drainage that was only minimally represented within the Granger Reservoir assemblages -- the exploitation of the available floral resources. The floral resources represent the addition of another resource to an already diffuse subsistence economy. The mounds and the associated deep hearths or earth ovens may represent the technological processes necessary for the efficient exploitation of the fall mast crop. Population increases in the Edwards Plateau region may have forced this reliance on a wider range of foods. The mounds themselves need not be relegated only to the function of acorn processing. The earth ovens probably were used for the processing of both faunal and floral food resources. The mounds may represent the intensive and recurrent use of certain locales for food processing. The seasonably specific utilization of these areas for the processing of the fall mast crop merely added to the already growing accumulation.

20.4 Conclusions

The investigation of the burned rock midden sites of the North Fork and Granger Reservoir Districts revealed a great deal of intersite variability related to the accumulations of burned rock. Several sites exhibited mounds of burned rock with peripheral massive lenses of burned rock and artifacts. Others, such as the Hawes Site (41WM56) exhibited a broad, non-structured mass of burned rock. At site 41WM73 the mound of burned rock was apparently the focal point of activity for little cultural debris was located around its periphery. Although the recognition of features and the recovery of macrobotanical remains associated with the mounds did not allow the assignment of a specific function to the burned rock midden as a part of the total settlement/ subsistence system, several conclusions and observations concerning the prevalent views of burned rock middens may be made.

The most recently investigated sites in the San Gabriel Reservoir Districts reveal that the "dump" hypothesis as presented by Sorrow (1969) and Hester (1970, 1971) is not applicable to most of the sites in the San Gabriel River Valley. Interestingly, the John Ischy Site (41WM49), which provided the original data base for the "dump" hypothesis, is an anomaly among the burned rock midden sites of the North Fork drainage. The original views of Kelley and Campbell (1942) and Suhm (1959) are more appropriate for the sites in the San Gabriel River Valley. The occurrence of these burned rock middens is clearly related to an abundance of limestone, the extensive use of stone-lined hearths or earth ovens, the recurrent use of favored localities, and geomorphological situations exhibiting stable or possibly degrading surfaces. The accumulation process was one of accretion upon a relatively stable surface. Living areas at these sites involved both the mound areas and areas peripheral to the mound.

The simultaneous appearance of burned rock middens, acorn remains and a significant quantity of ground stone tools in the North Fork drainage suggests that these sites also may represent the exploitation of seasonally available floral resources. The degree of dependency on the fall mast crop is not entirely clear from the San Gabriel data . Nevertheless, the diverse array of faunal resources present at all of these sites suggests that the floral resources were merely an addition to an already diffuse economy rather than a primary food resource of a focal economy as proposed by Weir (1976). The apparent population increase in the Edwards Plateau region (Weir 1976) required the exploitation of a broader spectrum of foods. As Asch et al. (1972:26-29) and Cohen (1977:49) have noted elsewhere in North America, population pressure may have forced the exploitation of less desirable resources which required extensive processing.

The diverse faunal and floral resources of these sites reflect a diffuse adaptation (Cleland 1966:64-66). The possible functional differences of the burned rock midden sites and the high degree of

variability in the size of sites and the intensity with which they are occupied also are characteristic of diffuse adaptations. Therefore, the hypothesis that the burned rock middens represent the processing of floral resources in earth ovens is overly simplistic. The stone griddles or the earth ovens probably were used to process both faunal and floral resources. The processing of the floral resources, primarily acorns, would merely have been seasonally specific.

The data recovered from the burned rock midden sites were informative concerning the depositional and cultural processes at work and the resources being utilized. However, the role of these sites in the larger settlement/subsistence system has not been adequately clarified. The interrelationship of these sites with smaller upland drainage sites needs to be determined. The relationship of the economic adaptation in the San Gabriel River Valley to other areas within Central Texas also needs to be determined. Perhaps, a more focal adaptation was operative in other areas of Central Texas. More detailed paleoenvironmental data are needed as necessary background information for an understanding of the fluctuations in population density and resource availability.

The accumulation processes of burned rock middens render the recognition of individual occupational episodes almost impossible. These sites accumulate through the superpositioning of midden debris on or adjacent to previously deposited refuse. This accretion process is further affected by both cultural and natural processes. The seemingly homogeneous deposit that results is a mixture of numerous occupational episodes. The types of data needed to test hypotheses concerning changing population densities, floral and faunal resource availability and periodicity of change may never be extracted from such deposits. Consequently, research efforts at these sites need to focus on the less massive lenses of cultural material peripheral to the mounds. Large horizontal excavation blocks must be utilized in an attempt to recognize isolated activity areas. The mounds themselves need only to be tested for comparative purposes. Ideally, as Sorrow (1969:51) has aptly noted, future research should be focused on sites containing discrete occupational strata. For too long research efforts have centered on the massive, artifact rich sites with a focus on the content of the mound and its chronological position within the prehistory of Central Texas. The continued mining of Central Texas burned rock midden sites for larger collections of artifacts is not needed; rather, problem specific research strategies aimed toward the delineation of population densities, resource availability, site formation processes, and the paleoenvironment are necessary. Any other approach may only perpetuate the enigma of burned rock middens and cause the unnecessary expenditure of public research funds.

21.0 An Evaluation of the "Phase" Concept

by

21.1 Duane E. Peter, T. R. Hays, and Marie-Anne Demuynck

Introduction

A major objective of this project was to provide an understanding of man's utilization of the San Gabriel River Valley through time. Essential to this purpose was a chronological framework in which inter-assemblage relationships could be effectively analyzed from a diachronic perspective. The establishment of this framework has been a primary goal for Central Texas archaeology (Sayles 1935; Kelley 1947a, 1947b, 1959: Suhm and Jelks 1962; Johnson, Suhm, and Tunnell 1962; Sorrow, Shafer, and Ross 1967; Sollberger and Hester 1972; Weir 1976; Jelks 1978; Prewitt 1981). In recent years, the culture-historical integration of the Central Texas data (Sorrow, Shafer and Ross 1967; Weir 1976; Prewitt 1981) has relied heavily on the archaeological units (component, phase) proposed by Willey and Phillips (1958). Although several investigators (Sorrow, Shafer, and Ross 1967; Johnson 1967) have recognized the inherent problems in establishing regional archaeological units for Central Texas, the definition of regional "phases" has been increasingly portrayed as a necessary step toward eventual explanation of cultural processes in Central Texas (Weir 1976; Prewitt 1981).

To provide a practical way for analyzing the inter-assemblage relationships of the San Gabriel Reservoir Districts, the chronological construct for Central Texas, as proposed by Weir (1976), Prewitt (1976a, 1976b) and Patterson (1977), was used to establish chronologically discrete horizons (components) which would display some degree of cultural homogeneity when compared with other units (Chapter 7.0). As is usual for Central Texas, the lack of sufficient radiocarbon samples from many components forced us to rely on typological "index markers" for the establishment of this framework. The very generalized nature of such a framework together with some incongruencies with the phase characterizations presented by Weir (1976) and Prewitt (1981) raised serious questions concerning the utility of the "phase" concept. As the inter-assemblage comparisons proceeded, it also was increasingly apparent that such a framework was not necessarily conducive to the eventual explanation of cultural processes. Therefore, the following discussion will present an evaluation of the utility of the phase concept as presently utilized in Central Texas. This discussion will involve a brief recapitulation of the concept as presented by Willey and Phillips (1958), a critical evaluation of Weir's (1976) and Prewitt's (1981) use of the concept, a comparison of the San Gabriel

data with the previous constructs, and suggestions concerning future avenues of research.

21.2 The Phase Concept in Central Texas

Analysis of the diachronic trends in the overall cultural record requires the delimitation of relatively homogeneous archaeological units or components within archaeological assemblages. Recent efforts (Weir 1976; Prewitt 1976a, 1976b, 1981) to accomplish this goal have relied mainly on the conceptual framework provided by Willey and Phillips (1958: 11-43), particularly their concept of the "phase." Willey and Phillips'(1958: 22) construct is particularly appealing to the above goals for it is defined as follows:

> ....an archaeological unit possessing traits sufficiently characteristic to distinguish it from all other units similarly conceived, whether of the same or other cultures or civilizations, spatially limited to the order of magnitude of a locality or region and chronologically limited to a relatively brief interval of time.

Although Willey and Phillps (1958) were not explicit concerning the nature of the traits sufficient for the recognition of individual phases, it is implicit from their integrative conceptual framework that such recognition should depend on more than the stylistic changes of a few "diagnostic" artifacts. More recent expansions (Cook 1976: 1-4) or alternative (Stoltman 1978: 705) to the Willey and Phillips conceptual framework make the point explicit. Cook (1976: 3), for example, proposes the construction of dimensional phases which requires the definition of phases in terms of dimensions such as style, technology, structure of segmentation, adaptation, trade, and mortuary practices, rather than in terms of several distinctive artifact types. From such a perspective, the traditional reliance in Central Texas on the changing morphologies of projectile points as "index markers" of culturally homogeneous units is hardly a proper basis for the establishment of a regional sequence.

Weir (1976) and Prewitt (1981) in recent attempts to provide a regional sequence for Central Texas have claimed adherence to the above-stated position. Weir (1976: 3) attempts to go beyond the typical chronology based on stylistic changes in projectile points with the aim of deriving spatially and temporally associated traits which would provide a basis for more appropriate phase designations. Weir (1976: 42) examines the temporal distribution of a number of traits of the Central Texas Archaic in addition to an analysis of the range of artifacts within the various phases and their diachronic patterning.

Weir's (1976: 97-105) application of the concepts of diversity and intensity indexes for recognizing the diachronic variability of the tool kits exhibits considerable potential and produces some very interesting patterning. Unfortunately, the patterning is probably biased by the small sample size rather than reflecting temporal patterns of the settlement/subsistence strategies. Although Weir fails to provide frequencies or counts of the number of tools involved in any of his calculations concerning the correlation coefficients of the indexes (diversity or intensity), he does state that 13,095 chipped stone artifacts from four sites containing six components of the Central Texas Archaic were involved in the statistical analyses (Weir 1976: 48-50). Using a very conservative estimate of the probable tool/debitage ratio and excluding the projectile points, it is highly unlikely that Weir's sample even approaches 300 tools from these six components. Since the projectile points (n = 362) and the biface fragments comprise the greatest portion of the total tool sample, some of the tool classes, such as the unifaces, are apparently very poorly represented among the four sites. Therefore, the diversity and intensity patterns exhibited by the bifacial and unifacial artifacts may be highly biased.

At a higher level of synthesis, Weir (1976) is apparently unaware of the sampling problems involved when attempting a regional synthesis from such a limited number of components. Weir's sample for the statistical indexes of most of the Archaic phases consists of a single component. Since the reliability of the resulting patterns is so questionable, Wier's characterization of the phases really rests on the projectile point styles and his trait list (Weir 1976: 42). Although Weir is to be commended for his attempt to go beyond the previous modeling efforts for Central Texas, it is not apparent that he achieved his goal of providing "more appropriate phase designations," especially at the regional level.

Like Weir's (1976) scheme, Prewitt's (1981) construction of "phases" relies chiefly on the distribution of projectile point styles. However, Prewitt (1981: 10-12) is explicit in his belief that phases can be recognized through such key "index markers" prior to the definition of their configuration. Prewitt does recognize that his chronological construct serves only as a means of description and not as an explanation. The chronological construct is seen as "the springboard from which interpretations of cultural processes can be achieved" (Prewitt 1981: 12). Whether or not these constructs can function in that manner will be discussed later.

An examination of Prewitt's construct quickly reveals that the descriptions of many of the early phases rely almost totally on key index markers and a largely conjectural time frame. The data base for the several phases varies significantly. Some phase descriptions use data from well excavated camp sites; others include artifacts from mortuary complexes; and still others rely on data from secondary contexts (i.e., surface sites). As with Weir's (1976) construct,

sampling bias at the regional level has a significant negative effect on the value of the results. Admittedly, Prewitt (1981: 20) presents the construct as a hypothetical working model to be modified as new data are available. On the other hand, several of the phase designations are premature given the presently available data base. Again, a temporal framework based on the morphological changes of the projectile point types is all that has been actually accomplished.

Although our own use of the phase concept was a helpful and expedient means of dealing with massive amounts of data related to interassemblage comparisons, it was realized that the utility of the concept suffers from several limitations. As with the Weir (1976) and Prewitt's (1981) chronological constructs, it soon became apparent that the adaptation of hunter-gatherers to Central Texas was quite conservative. Consequently, the only distinguishing characteristics of each phase are the "index markers" of projectile point styles. As noted earlier (Chapters 16.0 and 17.0) a very generalized tool kit was used throughout the occupational sequence of the San Gabriel River Valley. Although the relative importance of selected tools may have fluctuated through time, the overall character of the assemblage remained basically the same. Technologically, the lithic reduction processes also remain very conservative through time (Chapter 14.4).

As can be seen in the accompanying tables (Tables 21.2-1 to 8), the index markers of the various phases not only vary among the three chronological constructs, but are used differently in the recognition of particular phases. The variance among the three constructs partially reflects the fallacy of attempting to develop a regional sequence for Central Texas from a limited data base. Although the Granger and North Fork Reservoir Districts are well within the Central Texas region as depicted by Weir (1976: 4) and Prewitt (1981: 13), the predominant projectile point styles for particular time periods are not the traditional index markers. As Prewitt (1981: 13) aptly notes, the "geographical boundaries of specific episodes of adaptation will fluctuate within a given region." During the San Geronimo and Clear Fork Phases these boundaries appear to crosscut the Central Texas region. Social interaction between the Edwards Plateau and the Blackland Prairie appears to be limited, especially during the Clear Fork Phase.

Sites from the North Fork and Granger Reservoir Districts provided stratigraphic associations of radiocarbon dates and projectile point styles which previously had been largely conjectural, especially for the Early Archaic period. Unfortunately, this information did not provide the degree of temporal resolution which Prewitt's (1981) construct exhibits. Hoxie, Andice, Groups 9, 10, and 13, "Tortugas," Uvalde, Wells, and Group 12 projectile point types appear between 5,000 and 6,000 B.P. in that respective stratigraphic order rather than that proposed by Prewitt (1981). The San Gabriel data also raise serious

questions concerning the utility of Baird and Taylor type specimens as index markers. Baird and Taylor type points were found in an early context at the John Ischy Site (41WM49) and site 41WM304, but they are not markers restricted only to that early period of 4,600 and 5,000 B.P. as Prewitt (1981) postulates.

Although the San Gabriel data do not allow the finer subdivisions of the presently recognized Round Rock Phase that Prewitt (1981) proposes, the limited evidence from the Hawes Site (41WM56) does support the hypothesis that Pedernales points are a visible portion of the artifact assemblage after 3,500 B.P. and not earlier. However, the San Gabriel sites also yielded Pedernales, Marshall and Castroville points in stratigraphic association. Whether these associations are due to the original behavioral context of these specimens or later secondary depositional processes is not entirely clear. Nonetheless, the San Gabriel data do not support the finer subdivisions of the presently recognized San Marcos Phase proposed by Prewitt (1981). On the other hand, his proposed use of the Darl point ("Mahomet" in Prewitt's scheme) as an index marker of the latter protion of the presently recognized Twin Sisters Phase is supported by the San Gabriel data. Darl points are generally restricted stratigraphically to the upper portions of the Twin Sisters components of the San Gabriel assemblgaes.

Prewitt's chronological construct places much faith in the sensitivity and reliability of projectile points as chronological indicators. Indeed, excavation of stratified sites has shown that the morphological changes of the projectile points are temporally restricted; however, such a framework is very generalized. A detailed radiocarbon sequence is not available for most local sequences. Weir (1976: 29) relied on dates from Southwest Texas for most of his temporal framework. Although Prewitt (1981) refers to radiocarbon assays assembled by L. Nance (m.s.), the few available dates from Central Texas for the Early and Middle Archaic periods (Table 21.2-1) do not support the fine resolution of the stratigraphic positions of the projectile point styles that Prewitt (1981) postulates. Consequently, Prewitt's construct for the Early Archaic periods of Central Texas is largely intuitive and expresses possibly unwarranted faith in the temporal specificity of changing projectile point styles.

Excavation of the San Gabriel sites revealed that the natural and cultural processes affecting the accumulation of the midden deposits are such that the stratigraphic position of a given artifact may be totally disassociated from the other by-products of its original behavioral context. Of course, this observation is not new, for Johnson (1967) noted the problems in determining contextual associations in Central Texas sites and the resulting inability to define "phases." This lack of primary contextual integrity within many Central Texas sites raises serious questions concerning the viability of relying on projectile point styles for the recognition of components of a phase.

Inter-assemblage comparisons can only be made on a level so generalized that explanatory efforts are futile. For example, based on the present data, changes in occupational intensity and resource utilization cannot be accurately measured. It has usually been observed that the accumulation of burned rock middens slowed during the San Marcos Phase (Weir 1976); however, the San Gabriel data do not support this conclusion. Densities of lithic debitage and tools remain high during this phase. The total volume of burned rock output during this phase may have declined, but the length of the period is also significantly less than that of the preceding phase. However, without detailed radiocarbon sequences from the pertinent sites and chronometric densities of occupational debris (Ferring 1982), even these observations are very impressionistic and cannot be validated. Without an accurate description of variables, such as occupational intensity, explanations can hardly be expected to be developed from such a data base.

Although it might appear that further resolution of the temporal sequence alone would provide a firmer basis for explanation, it is unlikely due to the continued reliance on stylistically defined patterns. This continued reliance will merely produce more refined, culture-historical models rather than any explanatory models. Until functional or systemic approaches based on some general evolutionary premises are utilized, there will be no explanation of the sequence of prehistoric events in Central Texas. Admittedly, culture-historical models include explanatory concepts such as acculturation, diffusion and population integration; however, no attempt is made to draw generalizations concerning prehistoric hunter-gatherer adaptations. If explanation of prehistoric adaptations is our primary goal, then our research perspectives and methodologies must be reoriented. The continued improvement of culture-historical models will not allow us to reach that goal.

As Dunnell (1978) and Binford (1980) have noted, functional or systemic approaches are necessary if explanation is to be attained. Such approaches require that stratigraphically associated radiocarbon samples, paleoenvironmental data, and occupational debris be recovered from several localities and correlated to provide inferences concerning population densities, population differentiation and integration, subsistence productivity, and periodicity of change. The measurement of these dimensions requires a very different data base than the construction of a chronological scheme. The present data base from the North Fork and Granger Reservoir Districts provides a generalized culture-historical integration which is very impressionistic concerning the dimensions of population, differentiation, integration, energy, and environment. Explanation will depend on the derivation of appropriate hypotheses concerning these dimensions and the collection of well documented data bases which are crucial to the testing of these hypotheses.

Given the nature of Central Texas archaeological sites, is an approach which requires well dated occupational episodes from numerous localities even feasible? In other words, is a generalized culture-historical integration all that can be expected from the sites? Perhaps, it is, if our methodologies continue to emphasize sondage type excavation strategies, the excavation of massive sites with no stratigraphic separation of occupational episodes, and a continued reliance upon projectile point styles as temporal indicators. Explanation is only possible if archaeologists turn their attention to sites in which separate occupational episodes can be more easily identified and if they demonstrate more resourcefulness and willingness to experiment with new methodologies related to the dating of assemblages and the reconstruction of the paleoenvironment. Excavation strategies must involve the excavation of broad, horizontal expanses so that activity areas may be recognized through spatial analysis. It is only through these methods that a functional or systemic approach can be accomplished. A very few good sites providing the essential data for the functional approach could contribute more to the explanation of Central Texas prehistory than all of the sites dug thus far for the delineation of its culture history. Admittedly, culture-historical integration is one goal of archaeology; however, most archaeologists recognize the need to go beyond description to explanation. The nature of Central Texas sites renders this goal a difficult one; yet, this problem is not unique to Central Texas. As in other parts of North America, the research efforts of archaeologists must turn to new goals and methodologies instead of merely seeking to improve the present culture-historical models.

21.3 Summary

Although there are numerous problems associated with the use of a "phase" concept in Central Texas, its utilization will probably continue. The general lack of sufficient charcoal samples preserved in Central Texas sites will promote the continued reliance upon index markers for the determination of homogeneous assemblages. Although Johnson (1967) aptly noted the inability to define phases as intended by Willey and Phillips (1958) in most Central Texas sites, he proceeded to rely on the changing projectile point styles for establishing the contemporaneity of the assemblages for his statistical analysis of the temporal and spatial trends within Central and Southwest Texas. Unfortunately, this reliance on the projectile point styles has contributed to circularity in our reasoning. As Benfer (1981: 383) has noted, cultural stratigraphic or geograhpic units are often recognized through variations in frequencies of observed types. Those types, however, are defined only partly by morphology, but also by variation among cultural areas, the very entities defined in part by the observed types. The recognition of regional phases in Central Texas on the basis of changing projectile point styles is therefore regarded with much skepticism.

This skepticism has developed through the application of the phase concept to the San Gabriel data base. Although the general diachronic trend in projectile point styles is apparent, it is equally apparent that the site formation processes of the San Gabriel assemblages rarely produce isolated living floors with materials in primary contextual association. Consequently, relative frequencies of individual artifact types cannot be relied upon for establishing strict contemporaneity among assemblages.

The San Gabriel data also expose the fallacy of depicting "Central Texas" as presently defined as a homogeneous culture area. Occupational intensity, settlement/subsistence patterns, and stylistic dominance by the Pedernales point of the Round Rock Phase, as depicted by Weir (1976), are not readily apparent in the San Gabriel River Valley. During the earlier Clear Fork Phase, it also appears that the Blackland Prairie region may have been exploited by groups whose territorial ranges did not include the Edwards Plateau region. Any future attempt at regional synthesis,therefore needs to recognize the importance of sampling at the regional level.

The data recovered from sites of the North Fork and Granger Reservoir Districts provide a generalized overview of the occupational sequence of a particular locality - that of the upper San Gabriel River drainage. General patterns concerning occupational intensity, settlement/subsistence patterns, and technology have been recognized through the use of the phase concept. Utilization of the concept, however, has resulted only in the description of what happened to recognized cultural units at specific times and places. In other words, culture-historical integration has been achieved on a generalized time scale for the San Gabriel River Valley, but no explanation for the local sequence is accomplished. Explanations of Central Texas prehistory will require a reorientation of research perspectives and methodologies. The traditional reliance on the examination of stylistic patterns results only in a generalized culture-historical integration. Functional or systemic approaches must be developed and applied if explanation is to be accomplished.

TABLE 21.2-1

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

Frank Weir, 1976	Elton R. Prewitt, 1981	San Gabriel Project, 1981
NOT DISCUSSED	CIRCLEVILLE PHASE 7000 - 8500 B.P. Artifacts: *Chipped Stone:* - Angostura, Golondrina, Meserve and Scottsbluff projectile points - Clear Fork gouges - miscellaneous bifaces - drills - scrapers - gravers Other Stone: - hammerstones - grooved stone - grinding stones Bone Artifacts: - bone awls - carved bones Subsistence: hunting and gathering with emphasis on gathering	CIRCLEVILLE PHASE 7000 - 8000 B.P. Site types: Features: - basin-shaped hearths - burned clay/charcoal pits - informal burned rock scatters (hearths) - musselshell concentrations Artifacts: Flaked stone: - Angostura, Meserve and Golondrina projectile points - Scrapers are the most numerous tool class; complete bifaces, notches, denticulates, burins and gravers do also occur. - Clear Fork gouges Other Stone: - hammerstones (on flint core) Subsistence: hunting and gathering economy

TABLE 21.2-2

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

Frank Weir, 1976

SAN GERONIMO PHASE
5000 - 7000 B.P.

Site types: rockshelters, campsites and quarry sites
Features: burned rock midden, types 1,4. hearths, type 4
Artifacts:
Flaked Stone:
- Bell, Tortugas, Uvalde, Martindale, Garver and Angosturo projectile points
- triangular lanceilate and ovate bifaces thin and thick cross-section
- irregular and cortex bifaces
- Clear Fork and Guadalupe gouges
- convex and concave unilaterally trimmed unifaces
- bilaterally trimmed unifaces
- bilaterally, end trimmed unifaces
- unilaterally, end trimmed unifaces
- end trimmed unifaces
- canted trimmed unifaces
- circular unifaces
- irregular unifaces
- "beaked" unifaces
- burins (on snap, on truncation and dihedral)

Subsistence: diffuse huntings and gathering economy

Elton R. Prewitt, 1981

JARRELL PHASE
5000 - 6000 B.P.

Site types: terrace and blufftop
Features: large flat hearths
Artifacts:
Chipped Stone:
- Andice, Bell, Martindale and Uvalde projectile points, frequent edge grinding
- Clear Fork gouges
- miscellaneous bifaces
- scrapers

Other Stone:
- hammerstones
- grinding stones

Subsistence: huntings and gathering with probable emphasis on gatherings

SAN GERONIMO PHASE
+ 6000 - 7000 B.P.

Site types: terrace and bluff top
Features: possible medium and large basin shaped stone-lined hearths
Artifacts:
Chipped Stone:
- gower, toxic and wells projectile points
- Clear Fork and Guadalupe gouges
- miscellaneous bifaces
- scrapers

Subsistence: hunting and gathering

Site types: rockshelter, pointbar, bluff top, and terrace
Features: medium and large basin-shaped stone-lined fire hearths; burned day and charcoal-filled pits; musselshell concentrations

San Gabriel Project, 1981

SAN GERONIMO PHASE
5000 - 7000 B.P.

Site types:
Features:
- basin shaped hearths
- informal burned rock clusters (hearths)
- ash concentrations
- heat altered soil

Artifacts:
Flaked Stone:
- Hoxie, Wells, Gower , Uvalde. Martindale, Tortugas and groups 10, 12, 13 projectile points in the North Fork Reservoir, - Hoxie, Andice, "Tortugas", Uvalde, Wells, and group 9, 10, 12, 13 in the Granger Reservoir.
- Notched pieces, denticulates and burins are the most numerous tool classes. Axes and complete bifaces and preforms are relatively important Scrapers are low, and gouges are absent.

Other Stone:
- hammerstones (on flint cores)
- mano's (granite)
- mamiports (quartzite)

Bone Artifacts:
- bone tools

Shell Artifacts:
- shell beads
- possible musselshell pendants

Subsistence: Diffuse hunting and gathering economy; emphasis on faunal resources

TABLE 21.2-3

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

Frank Weir, 1976

CLEAR FORK PHASE 4000 - 5000 B.P.

Site types: rockshelters, campsites, quarrysites

Features:

Flaked stone:
- Nolan, Travis and Tortugas projectile points
- Clear Fork gouges
- triangular lanceolate and aate bifaces thin and thick in cross-section
- irregular and cortex bifaces
- perforators
- convex and concave unilaterally trimmed unifaces
- bilaterally, end trimmed unifaces
- unilaterally, end trimmed unifaces
- end trimmed unifaces
- canted trimmed unifaces
- circular unifaces
- irregular unifaces
- "nosed" unifaces
- "beaked" unifaces
- burins (on truncation and on snap, dihedral)

Subsistence: Focal hunting and gathering economy; emphasis on floral resources

Elton R. Prewitt, 1981

CLEAR FORK PHASE 4000 - 4600 B.P.

Site types: terrace and uplands

Features:
- burned rock middens (established)

Artifacts:

Chipped stone:
- Nolan and Travis projectile points
- Clear Fork gouges
- bifaces
- scrapers
- strangulated scrapers

Other Stone:
- grinding stones

Subsistence: relatively balanced hunting and gathering

OAKALLA PHASE 4600 - 5000 B.P.

Site types: terrace and bluff top

Features:
- burned rock middens (beginning)
- large flat hearths
- medium basin hearths

Artifacts:

Chipped Stone:
- Paird and Taylor projectile points
- Clear Fork gouges

Subsistence: hunting and gathering

San Gabriel Project, 1981

CLEAR FORK PHASE 4000 - 5000 B.P.

Site types: alluvial terrace

Features:
- beginning burned rock midden formation (type 1, NF only) with basin shaped hearths or ovens at base.
- less classic burned rock middens (type 4)
- basin shaped hearths (small)
- informal burned rock clusters (hearths)
- probable storage pit
- faunal dump area's

Artifacts:

Flaked stone:
- Bulverde, Nolan, Travis, Tortugas, Group 2,4,5,7,11,14 projectile points in the North Fork Reservoir; Dawson, Bulverde, Travis, "Tortugas" and group 1,2,4,7 in the Granger Reservoir
- Scrapers are very important in the North Fork Reservoir, while burins, notches and denticulated pieces are also high. Other tool classes are low. Drills are present. Notches and denticulates are most important in the Granger Reservoir. Burins are high, but less than in preceding period. Borer tools are relatively important. One Clear Fork gouge was found. Complete bifaces and preforms are relatively important in both Reservoirs

Other Stone:
- mano's (quartz, quartzite)
- mano-anvil's (quartz, quartzite)
- grinding slabs (flint, sandstone, quartzite)

TABLE 21.2-3 continued

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

	Frank Weir, 1976	Elton R. Prewitt, 1981	San Gabriel Project, 1981
CLEAR FORK PHASE			- maniports (quartzite) - mortar (limestone) Bone Artifacts: - numerous bone tools - possible ornaments - possible pendant Shell Artifacts: - shell beads - mussel shell pendants - possible mussel shell tools Subsistence: Granger - Diffuse hunting and gathering economy; emphasis on faunal resources; North Fork - Diffuse hunting and gathering economy; utilization of both faunal and floral resources; possible differentiation of site functions.

TABLE 21.2-4

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

Frank Weir, 1976

ROUND ROCK PHASE 2600 - 4200 B.P.

Site types: rockshelter, campsites, quarrysites

Features:
- burned rock midden, type 1,4
- hearths, type 4
- bedrock mortars and grinding slabs
- human burials (secondary interment and burial in sinkholes)

Artifacts:

Flaked stone:
- Pedernales (Bulverde) projectile points
- triangular, lancelate and bifaces, thin and thick in cross-section
- irregular and cortex bifaces
- perforators
- gouges
- concave unilaterally trimmed unifaces
- bilaterally, end trimmed unifaces
- end trimmed unifaces
- burins (on snap only)

Subsistence: local hunting and gathering economy; emphasis on floral resources

Elton R. Prewitt, 1981

ROUND ROCK PHASE 2600 - 3400 B.P.

Site types: terrace, upland, rockshelter

Features:
- burned rock middens
- small and medium basin hearths
- burned clay, charcoal lenses and pits
- lithic debris concentrations

Artifacts:

Chipped stone:
- Pedernales projectile points
- bifaces
- unifaces

Other stone:
- grinding stones

Subsistence: balanced hunting and gathering

MARSHALL FORD PHASE 3400 - 4000 B.P.

Site types: terrace, upland, rockshelter

Features:
- burned rock middens

Artifacts:

Chipped stone:
- Bulverde projectile points
- bifaces
- unifaces

Other stone:
- grinding stones

Subsistence: relatively balanced hunting and gathering

San Gabriel Project, 1981

ROUND ROCK PHASE 2600 - 4000 B.P.

Site types: alluvial terrac

Features:
- classic burned rock midden (type 1)
- less classic burned rock midden (type 4) by North Fork only.
- basin shaped hearths
- informal burned rock scatter (hearth)
- larger pit hearths or ovens
- burned clay/charcoal pits

Artifacts:

Flaked stone:
- Castroville, Marshall, Pedernales and Bulverde projectile points in the North Fork Reservoir; Pedernales in the Granger Reservoir
- Notched pieces and scrapers are predominant in the North Fork Reservoir, followed by denticulated pieces and burins. Many other tool classes are present but low. Drills do occur. The Granger Reservoir assemblage was dominated by burins, and by truncated pieces and bifaces to a lesser degree. All other tool classes present are low in number.

Other stone:
- hammerstones (on flint cores)
- mano's (quartz, flint, granite, sandstone)
- mano/hammerstones (quartz)
- anvils (limestone)
- grinding slab, (quartzite)

Bone Artifacts- bone tools present
- bone bead

Subsistence: Granger - Diffuse hunting and gathering economy; emphasis on faunal resources; intensity of activity is low North Fork - Diffuse hunting and gathering economy; utilization of both faunal and floral resources; possible differentiation of site functions.

TABLE 21.2-5

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

Frank Weir, 1976

SAN MARCOS PHASE 1800 - 2800 B. P.

Site types: rockshelters, campsites quarysites, kill sites.

Features:
- burned rock middens, types 1,2,3,4.
- hearths, types 2,3,4,5.
- bedrock mortars & grinding surfaces
- biface
- human burials (in sinkholes)
- animal burials (dog)

Artifacts:

Flaked stone:
- Marshall, Castroville, Montell, Marcos, Williams and Lange projectile points
- triangular and ovate bifaces, thin and thick cross-section
- irregular and cortex bifaces
- perforators
- convex unilaterally trimmed unifaces
- concave unilaterally trimmed unifaces
- bilaterally trimmed unifaces
- bilaterally end trimmed unifaces
- unilaterally end trimmed unifaces
- end trimmed unifaces
- "nosed" unifaces
- "beaked" unifaces
- burins (on snap, dihedral) are few

Subsistence: Probable focal endeavor of bison hunting, but economy had become more diffuse overall.

Elton R. Prewitt, 1981

UVALDE PHASE 1750 - 2250 B.P.

Site types: terrace, upland and rockshelter

Artifacts:

Chipped stone:
- Castroville, Marcos & Montell projectile points
- bifaces
- unifaces

Other stone:
- grinding stones

Bone Artifacts:
- ulna flakers

Subsistence: hunting and gathering with probably light emphasis on gathering

SAN MARCOS 2250 - 2600 B. P.

Site types: terrace, upland and rockshelter

Features:
- burned rock midden
- large flat hearths
- small and medium basin hearths
- lithic debris concentrations
- freshwater musselshell concentrations
- (one) cremation

Artifacts:

Chipped stone:
- Marshall, Williams and Large projectile points
- bifaces
- scrapers
- small concave unifaces

Other stone:
- grinding stones

Shell artifacts:
- marine shell ornaments

Subsistence: hunting and gathering with probably slight emphasis on gathering

San Gabriel Project, 1981

SAN MARCOS PHASE 1750 - 2600 B. P.

Site types: alluvial terrace

Features:
- burned rock midden (declinings, type 1)
- less classic burned rock midden (type 4)
- basin-shaped hearths
- flat informal rock clusters (hearths)

Artifacts:

Flaked stone:
- Marcos, Montell, Williams, Castroville, and Marshall projectile points
- Notched pieces and scrapers are predominant in both reservoirs, while denticulated pieces and burins are still relatively numerous in the Granger Reservoir. Boring tools become more prominent also; they are mostly gravers, with some drills. Complete bifaces are well represented. One unnamed type of gouge was found.

Other Stone:
- hammerstones (on flint cores) Granger Reservoir only
- grinding slabs (quartzite)

Bone Artifacts:
- bone tools

Subsistence: Diffuse hunting and gathering economy; utilization of both faunal and floral resources; intensity of activity possibly lower in Granger Reservoir.

TABLE 21.2-6

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

Frank Weir, 1976

TWIN SISTER PHASE 700 - 2000 B.P.

Site types: rockshelters, campsites, quarry sites.

Features:
- burned rock midden, types 2, 3, 4.
- hearth, types 1, 2, 3, 4, 5.
- "tipi" rings
- bedrock mortars and bedrock grinding surfaces
- biface caches, musselshell caches
- human burials, , secondary, in sinkholes
- animal burials (dog)

Artifacts:

Flaked Stone:
- & Ensor projectile points
- corner tang knives
- triangular and aate bifaces, thin cross-section.
- irregular and cortex bifaces
- convex unilaterally trimmed unifaces
- concave unilaterally trimmed unifaces
- unilaterally end trimmed unifaces
- end trimmed unifaces
- "nosed" unifaces
- "beaked" unifaces
- burins (on snap, on truncations, dihedral)

Other stones:
- boatstones

Subsistence: diffuse hunting and gathering, loosely organized roaming groups

Elton R. Prewitt, 1981

DRIFTWOOD PHASE 1250 - 1400 B.P.

Site types: terrace and rockshelter

Features:
- small and medium basinhearths
- burned charcoal/clay lenses and pits
- isolated fixed burials

Artifacts:

Chipped Stone:
- Mahomet projectile points
- Hare bifaces
- miscellaneous bifaces
- small concave unifaces
- gravers

Other Stone:
- polished chert flakes
- grinding stones
- hammerstones

Bone Artifacts:
- beads
- awls

Shell Artifacts:
- fresh water musselshell pendants

Subsistence: basic hunting and gathering, with emphasis on gathering

TWIN SISTERS PHASE ± 1400 - 1750 B.P.

Site types: terrace and rockshelter

Features:
- small, medium, and large basin hearths
- arcuate hearths
- burned clay/charcoal lenses and pits
- musselshell caches
- isolated fixed burials

Artifacts:

Chipped Stone:
- Ensor projectile points
- Erath and San Gabriel bifaces
- Clear Fork gouges

San Gabriel Project, 1981

TWIN SISTERS PHASE 1250 - 1750 B.P.

Site types: alluvial terrace

Features:
- basin shaped hearths or ovens, often rock-lined with lenses of heat altered soil (Granger Res. only)
- basin shaped hearths
- informal burned rock clusters (hearths)
- arcuate hearths (Granger Res. only)
- burned clay/charcoal pits
- area's of heat altered soil
- re-occurence of burned rock midden (type 4, N.F. Res. only)
- storage pits

Artifacts:

Flaked Stone:
- Darl, Frio, Ensor, Fairland and Fairland/Ensor projectile points in the North Fork Reservoir
- Darl, Ensor, Fairland and Fairland/Ensor projectile points in Granger Reservoir
- Many complete bifaces and preforms, especially in the Granger Reservoir. Burins are high in North Fork, low in the Granger Reservoir. In both reservoirs there are many notched pieces and boring tools are relatively important. They are mainly gravers as well as few drills. Backert pieces are important, scrapers are moderately well represented. Two axes are present, but no gouges

Other Stone:
- hammerstones mostly on exhausted flint cores.
- mano's (sandstone)

TABLE 21.2-6 continued

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

Frank Weir, 1976		Elton R. Prewitt, 1981		San Gabriel Project, 1981
	TWIN SISTERS PHASE ARCHAIC	- perforators - gravers - *large and small concave* unifaces - scrapers Other Stone: - crushers - grinding stones - *boat* stones - stone gorgets Shell Artifacts: - freshwater shell pendants - marine shell gorgets *Subsistence:* hunting and gatering with decided emphasis on gathering	TWIN SISTERS PHASE ARCHAIC	- *mano's/anvils (granite)* - grinding slabs (quartz, quartzite, limestone, sandstone) - anvils (limestone) - (sandstone) Bone Artifacts: - numerous bone tools, one decorated Subsistence: Diffuse hunting and gathering economy; decline of activity in North Fork Reservoir

TABLE 21.2-7

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

Frank Weir, 1976	Elton R. Prewitt, 1981	San Gabriel Project, 1981
NOT DISCUSSED	AUSTIN PHASE 650 - 1250 B.P. Site types: terrace and rockshelter Features: - small, medium & large basin hearths - burned clay/charcoal lenses and pits - cemeteries (cemeteries & isolated interments, cremation and inhumation) Artifacts: Chipped stone: - Friday bifaces - miscellaneous bifaces - Clear Fork gouges - scrapers - small concave unifaces Other stone: - *grinding stones* - hammerstones - pointed pebbles Bone Artifacts: - awls - ulna flakers - beads Shell Artifacts: - marine shell bead pendants Subsistence: hunting and gathering, with greater dependance on the later.	AUSTIN PHASE 650 - 1250 B.P. Features: - rock-lined basin-shaped hearths and/or ovens often with heat-altered soil (Granger Reservoir only) - basin-shaped hearths - informal burned rock cluster (hearths) - burned clay/charcoal pits - storage pits - cemeteries (inhumation & cremation) Artifacts: Flaked stone: - Scallorn projectile points - decrease in tool density. Notched pieces are the predominant artifacts, followed by denticulated pieces, truncations, backed pieces and complete bifaces. Burins are rare, scrapers are absent, as are gouges and axes. Other stone: - mano's (Quartzite) - grinding slabs (sandstone) Bone Artifacts: - bone tools Subsistence: Diffuse hunting and gathering economy; emphasis on small animals; continued decline of activity in North Fork Reservoir.

TABLE 21.2-8

COMPARISON OF CENTRAL TEXAS "PHASE" CHARACTERISTICS

Frank Weir, 1976	Elton R. Prewitt, 1981	San Gabriel Project, 1981
NOT DISCUSSED	TOYAH PHASE 200 - 650 B.P. Site types: terrace and rockshelter Features: large flat hearths large and medium basin hearths burned clay/charcoal lenses pits cemeteries (isolated interments) Artifacts: Chipped stone: - *Perdiz & Clifton projectile points* - Carington bifaces - four-bevel bifaces - endscrapers - drills Other stone: - grinding stones Bone Artifacts: - awls - *ulna flakers* - various bison bone tools - beads Shell Artifacts: - pendants (musselshell) Ceramics: - Leon Plain - Doss Redware - Imported Miscellaneous: - wooden & cane arrowshafts - digging sticks - basketry, cordage - miscellaneous perishable artifacts Subsistence: hunting and gathering, reappearance of Bison possible horticulture (corncobs) or trade.	TOYAH PHASE 150 - 650 B.P. Site types: Features: (Granger Reservoir only) - rocklined basin-shaped hearths - informal burned rock clusters (hearths) - cluster of burned Exogyro shells (hearth Artifacts: Flaked stone: - Perdiz projectile points - few other artifacts; mainly retouched pieces and biface fragments. No scrapers and no drills; one complete biface and one axe. Definite decrease in tool density. Bone Artifacts: - bone tools Shell Artifacts: - musselshell pendant Ceramics: - Leon Plain Subsistence: Diffuse hunting and gathering economy's increased utilization of prairie fauna (bison, prairie chicken) in Granger Reservoir; North Fork Reservoir used very infrequently.

IX: LITERATURE CITED

Ahler, J.A.
1971 Projectile Point Form and Function at Rodgers Shelter, Missouri. Missouri Archaeological Society Research Series, Number 8.

1973 Post-Pleistocene Depositional Change at Rodgers Shelter, Missouri. Plains Anthropologist 18(59):1-26.

Alexander, H.L. Jr.
1963 The Levi Site: A Paleo-Indian Campsite in Central Texas. American Antiquity 28:510-528.

Allison vs. Froehlke, Civil Action No. A-71-CA-84, June 30, 1975.

Anderson, J.E.
1962 Human Skeleton for Archaeologists. National Museum of Canada, Ottawa, Canada.

Arnold, J. B. and G. B. Kegley
1974 A Magnetometer Survey of a Prehistoric Village in Western Texas. Paper presented at Society for American Archaeology, Washington, D.C.

Asch, N.B., R.I. Ford, and D.L. Asch
1972 Paleoethnobotany of the Koster Site: the Archaic Horizons. Illinois State Museum Research Papers 6.

Bailey, V.
1905 Biological Survey of Texas. North American Fauna, U.S. Biological Survey No. 25.

Barnes, D. Alfred
1939 The Difference between Natural and Human Flaking on Prehistoric Flint Implements. American Antiquity 41(1):99-112.

Bass, W.
1971 Human Osteology. Special Publication, Missouri Archaeology Society, University of Missouri, Columbia, Missouri.

Baum, Willa K.
1977 Transcribing and Editing Oral History, American Association for State and Local History, Nashville.

Baumhoff, M.A.
1963 Ecological Determinants of Aboriginal California Populations. University of California Press.

Beavers, A.H. and I. Stephen
1958 Some Features of the Distribution of Plant-Opal in Illinois Soils. Soil Science Society of America Proceedings 86(1):1-5.

Benfer, Robert A.
1967 A Design for the Study of Archeological Characteristics. American Anthropologist 69(6):719-730.

1970 Review of Towards a Statistical Overview of the Archaic Cultures of Central and Southwest Texas, by Leroy Johnson, Jr. American Antiquity 35:118-119.

Benfer, Robert A. and Alice N. Benfer
1981 Automatic Classification of Inspectional Categories: Multivariate Theories of Archaeological Data. American Antiquity 46(2):381-396.

Bentley, H.L.
1898 Cattle Ranges in the Southwest: A History of the Exhaustion of the Pasturage and Suggestions for its Restorage. U.S.D.A. Farmers Bulletin 72.

Berry, A.C. and R.J. Berry
1967 Epigenetic Variation in the Human Cranium. Journal of Anatomy 101:361-379.

Birdsell, Joseph B.
1968 Some Predictions for the Pleistocene Based on Equilibrium Systems Among Recent Hunter-Gatherers. In Man the Hunter, edited by Richard Lee and Irven DeVore, pp. 229-240. Aldine Publishing Company, Chicago.

Birkeland, P.W.
1974 Pedology, Weathering and Geomorphological Research. Oxford University Press.

Blair, W.F.
1950 The Biotic Provinces of Texas. Texas Journal of Science 2(1):93-117.

Bohrer, L. Vorsila
1970 Ethnobotanical Aspects of Snaketown, a Hohokam Village in Southern Arizona. American Antiquity 35:413-430.

1975 The Prehistoric and Historic Role of the Cool-Season Grasses in the Southwest. Economic Botany 29:199-207.

Bohrer, L. Vorsila and Karen R. Adams
1977 Ethnobotanical Techniques and Approaches at Salmon Ruin, New Mexico. Eastern New Mexico University Contributions in Anthropology 8(1).

Bolton, Herbert E.
1962 Texas in the Middle Eighteenth Century. Russell & Russell, Inc., New York.

Bond, Clell L.
1978 Three Archeological Sites at Hoxie Bridge, Williamson County, Texas. Anthropological Laboratory Texas A&M University Report No. 43.

Bordaz, Jacques
1970 Tools of the Old and New Stone Age. American Museum of Natural History, Garden City, New York.

Bordes, F.
1961 Typologie du Paleolithique Ancien at Moyen, Vols. I and II. Publications de l'Institut de Prehistoire de l'Universite de Bordeaux, Memoire No. 1.

Bordes, François
1947 Etude Comparative des différentes techniques de taille du silex et des roches dures. L'Anthropologie 51:1-29.

Breiner, S.
1973 Applications Manuel for Portable Magnetometers. Geometrics Incorporated. Sunnyvale, California.

Brezillon, Michel N.,
1971 La dénomination des objects de pierre taillée. Matériaux pour un vocabulaire des préhistoriens de langue françiase. Editions du centre national de la recherche scientifique, Paris.

Brose, S. David
1975 Functional Analysis of Stone Tools: A Cautionary Note on the Role of Animal Fat. American Antiquity 40:86-94.

Brothwell, D.
1963 Digging up Bones. British Museum, London.

Bryant, V.M. Jr.
1977 A 16,000 Year Pollen Record of Vegetational Change in Central Texas. Palynology 1:143-150.

1978 Analysis of Soils and Fossil Pollen from 41WM21: Archaeological Test Excavations at 41WM21 in Granger Reservoir, Williamson County, Texas. Report No. 37. Anthropology Department, Texas A&M University.

Bryant, V.M. Jr. and D.A. Larson
1968 Pollen Analysis of The Devil's Mouth Site, Val Verde County, Texas. In The Devil's Mouth Site, The Third Season. Papers of the Texas Archeological Salvage Project 14:57-70.

Bryant, V.M. and Harry J. Shafer
1977 The Late Quaternary Paleoenvironment of Texas: A Model for the Archeologist. Bulletin of the Texas Archeological Society 48:1-25.

Buikstra, J.
1976 Hopewell in the Lower Illinois Valley: A Regional Study of Human Biological Variability and Prehistoric Mortuary Behavior. Northwestern University Archaeological Program, Scientific Papers 2.

Burch, J.B.
1975 Freshwater Unionacean Clams (Mollusca: Pelecypoda) of North America (2nd Edition). Malacological Publications.

Bureau of Economic Geology
1974 Geologic Atlas of Texas, Austin Sheet. University of Texas, Austin.

Burr, J.G.
1932 Fishes of Texas. Texas Game and Fish Commission. Bulletin 5.

Burt, W.H. and R.P. Grossenheider
1964 A Field Guide to the Mammals. Houghton Mifflin Co., Boston.

Butler, Barbara H.
1974 Human Skeletal Material from the Loeve-Fox Site: A Preliminary Report. In Archaeological Investigations at the Loeve-Fox Site, Williamson County, Texas, by Elton Prewitt, pp. 122-131. Texas Archeological Survey Research Report 49, University of Texas at Austin.

1980 Animal Exploitation in the Delaware Canyon Area. In The Late Holocene Prehistory of Delaware Canyon, Oklahoma, edited by C. Reid Ferring, Chap. 6. Institute of Applied Sciences, Contributions in Archaeology, No. 1. North Texas State Univ., Denton, TX.

Byrd, Clifford L.
1971 Origin and History of the Uvalde Gravel of Central Texas. Baylor Geological Studies, Bulletin 20(Spring).

Caldwell, J.R.
1958 Trend and Tradition in the Prehistory of the Eastern United States. American Anthropological Association, Memoir 88.

Campbell, Thomas N.
1948 The Merrell Site: Archaeological Remains Associated with Alluvial Terrace Deposits in Central Texas. Bulletin of the Texas Archeological and Paleontological Society 19:7-35.

Caras, Roger A.
1967 North American Mammals. Meredith Press, New York.

Carbone, Victor A.
1977 Phytoliths as Paleoecological Indicators. Annals of the New York Academy of Sciences 288:194-205.

Carpenter, J.R.
1940 The Grassland Biome. Ecological Monographs 10:617-684.

Castaneda, Carlos E.
1936 Our Catholic Heritage in Texas (5 Vol.). Von Boeckmann-Jones, Austin.

Catana, A.J.J. Jr.
1963 The Wandering Quarter Method of Estimating Population Density. Ecology 44:349-360.

Cattell, R.B.
1965 Factor Analysis: an Introduction to Essentials. Biometrics 21:190-215, 405-435.

Chamberlain, V. Ralph
1911 The Ethnobotany of the Gosiute Indians of Utah. American Anthropological Association, Memoir 11.

Chaplin, R.E.
1971 The Study of Animal Bones from Archaeological Sites. Seminar Press, New York.

Cheatum E.P. and D. Allen
1965 Pleistocene Land and Freshwater Mollusks from North Texas. Sterkiana 18:1-16.

Cheatum, E.P. and R.W. Fullington
1971 The Aquatic and Land Mollusca of Texas. Part One, the Recent and Pleistocene Members of the Gastropod Family Polygyridae in Texas. Dallas Museum of Natural History, Bulletin I.

1973 The Aquatic and Land Mollusca of Texas. Part Two, the Recent and Pleistocene Members of the Pupillidae and Urocoptidae (Gastropoda) in Texas. Dallas Museum of Natural History, Bulletin I.

Cheatum E.P. and B.H. Slaughter
1966 Notes on the alluvial history of the Lampasas River, Texas. Journal of Graduate Research Center, Southern Methodist University 35:48-54.

Christenson, Andrew L. and Dwight W. Read
1977 Numerical Taxonomy, R-Mode Factor Analysis, and Archaeological Classification. American Antiquity 42(2):163-179.

Clarke, A.H. and C. D. Berg
1959 The Freshwater Mussels of New York. Agricultural Experimental Station, Cornell University, New York.

Clarke, David L.
1968 Analytical Archaeology. Methuen, London.

Cleland, Charles E.
1966 The Prehistoric Animal Ecology of the Upper Great Lakes Region. Museum of Anthropology, University of Michigan, Anthropological Papers No. 29.

1976 The Focal-diffuse Model: an Evolutionary Perspective on the Prehistoric Cultural Adaptations of the Eastern United States. Mid-Continental Journal of Archaeology 1(1):59-76.

Cohen, Mark N.
1977 The Food Crisis in Prehistory. Yale University Press.

Collins, Michael B.
1973 The Devil's Hollow Site, a Stratified Archaic Campsite in Central Texas. Bulletin of the Texas Archeological Society 43(1972):77-100.

Conant, R.
1975 A Field Guide to Reptiles and Amphibians. Houghton Mifflin Co., Boston.

Cook, Thomas Glen
1976 Koster: An Artifact Analysis of Two Archaic Phases in Westcentral Illinois. Northwest University Archaeological Program, Prehistoric Records No. 1, Koster Research Reports No. 3, Evanston.

Cornwall, I.W.
1974 Bones for the Archaeologist. J.M. Dent and Sons Ltd., London.

Correll, D.S. and M.C. Johnston
1970 Manual of the Vascular Plants of Texas. Texas Research Foundation, Renner, Texas.

Corruccini, R.S.
1974 An Examination of the Meaning of Cranial Discrete Traits for Human Skeletal Biological Studies. American Journal of Physical Anthropology 40:425-446.

Cowgill, George L.
1977 The Trouble with Significance Tests and What We Can Do About It. American Antiquity 42:350-368.

Crabtree, E. Don
1972 An Introduction to Flintworking. Occasional Papers of the Idaho State University No. 28, Pocatello.

Crawford, Daymond D.
1965 The Granite Beach Site, Llano County, Texas. Bulletin of the Texas Archeological Society 36:71-97.

Creel, Darrell
1978 An Archaeological Survey in the South Concho River Area, West Central Texas. Bulletin of the Texas Archeological Society 49:241-307.

Dahlberg, A.A.
1949a The Dentition of the American Indian. In Papers of the Physical Anthropology of the American Indian, edited by W.S. Laughlin, pp. 138-176. Viking Fund, New York.

1949b Materials for the Establishment of Standards for Classifications of Tooth Characters, Attributes and Techniques in Morphological Studies of the Dentition. Zollar Laboratory of Dental Anthropology, Department of Anthropology, University of Chicago.

Dalquest, W.W. and C.W. Hibbard
1965 1,350-year-old Vertebrate Remains from Montague County, Texas. Southwest Naturalist 10:315-316.

Damas, D.
1969 Environment, History, and Central Eskimo Society. National Museum of Canada Bulletin 230.

Damon, P.E., C.W. Ferguson, A. Long and E.I. Wallick
1974 Dendrochronologic Calibration of the Radiocarbon Time Scale. American Antiquity 39(2):350-366.

Dary, D.A.
1974 The Buffalo Book, the Full Saga of the American Animal. Swallow Press, Chicago.

Davis, W.B.
1974 The Mammals of Texas. Texas Parks and Wildlife Department, Bulletin 41.

de Heinzelin de Braucourt, Jean
1962 Manuel de typologie des industries lithiques. Institut royal des sciences materielles de Belgique, Brussels.

Denton, Joe T.
1976 No Name Creek Site: A Terrace Site of the Middle and Late Archaic Period in Gillespie County, Texas. State Department of Highways and Public Transportations Publications in Archaeology 7:1-44.

Dibble, D.S. and D. Lorrain
1968 Bonfire Shelter: A Stratified Bison Kill Site, Val Verdes County, Texas. Miscellaneous Paper of the Texas Memorial Museum I.

Dice, L.R.
1943 The Biotic Provinces of North America. University of Michigan Press, Ann Arbor.

Dillehay, Tom D.
1974 Late Quaternary Bison Population Changes on the Southern Plains. Plains Anthropologist 19-65:180-196.

1975 Prehistoric Subsistence Exploitation in the Lower Trinity River Delta, Texas. Texas Archeological Survey, Research Report No. 51.

Dixon, W.J.
1953 Processing Data for Outliers. Biometrics 9:74-89.

Dixon, W.J. (editor)
1975 BMDP: Biomedical Computer Programs. University of California Press, Berkeley.

Dixon, Wilfrid J. and Frank J. Massey, Jr.
1969 Introduction to Statistical Analysis Third Edition. McGraw Hill, Inc., New York.

Dodd, J.D.
1968 Grassland Associations in North America. In Grass Systematics, edited by F.W. Gould. McGraw-Hill, New York.

Doran, J.E. and F.R. Hodson
1975 Mathematics and Computers in Archaeology. Harvard University Press, Cambridge, MA.

Duffield, Lathel F.
1963 The Strawn Creek Site: A Mixed Archaic and Neo-American Site at Navarro Mills Reservoir, Navarro County, Texas. Report submitted to the National Park Service by the Texas Archaeological Salvage Project, University of Texas, Austin.

1970 Some Panhandle Aspect Sites: Their Vertebrates and Paleoecology. Unpublished Ph.D. dissertation, Department of Anthropology, University of Wisconsin.

Dunnell, Robert C.
1971 Systematics in Prehistory. The Free Press, New York.

1978 Comment on Temporal Models in Prehistory: An Example from Eastern North America, by James B. Stoltman. Current Anthropology 19(4):732.

Eddy, Frank W.
1973 Salvage Archeology in the Laneport Reservoir District, Central Texas. Report submitted to the National Park Service by the Texas Archeological Survey, University of Texas at Austin.

Epstein, F. Jeremiah
1960a Notes of Burins. Ohio Archaeologist 10(2):50-51.

1960b Burins from Texas. American Antiquity 26:93-97.

1963 The Burin-faceted Projectile Point. American Antiquity 29(2): 187-201.

Ernst, C.H., and R.W. Barbour
1972 Turtles of the United States. University of Kentucky Press, Lexington.

Evans, G. John
1978 An Introduction to Environmental Archaeology. Cornell University Press, Ithaca, New York.

Federal Reporter
1973 Vol. 470F. 2d. West Publishing Co., St. Paul

Fenneman, N.M.
1931 Physiography of Western United States. McGraw-Hill, New York.

1938 Physiography of Eastern United States. McGraw-Hill, New York.

Ferring, C. Reid
1979 Technological Variability and Change in the Late Paleolithic of the Negev. Unpublished Ph.D. Dissertation, Department of Anthropology, Southern Methodist University.

1982 The Late Holocene Prehistory of Delaware Canyon, Oklahoma. Institute of Applied Sciences, Contributions in Archaeology, No. 1 North Texas State University, Denton, Texas.

Fox, Anne A., and Thomas R. Hester
1976 An Archaeological Survey of Coleto Creek, Victoria and Goliad Counties, Texas. Center for Archaeology Research, The University of Texas at San Antonio, Survey Report No. 18.

Freeman, Martha Doty
1976 A History of the Hoxie San Gabriel Ranch: Williamson County, Texas. Texas Archaeological Survey, Research Report No. 63, Austin.

Frison, George C.
1974 The Casper Site: a Hell Gap Bison Kill on the High Plains. Academic Press, New York.

Fuller, W.A.
1959 The Horns and Teeth as Indicators of Age in Bison. Journal of Wildlife Management 23(3):342-344.

Fullington, R.W. and W.L. Pratt, Jr.
1974 The Aquatic and Land Mollusca of Texas-Part Three, the Helicinidae, Carychiidae, Achatinidae, Bardybaenidae, Bulimulidae, Cionellidae, Haplotrematidae, Helicidae, Oreohelicidae, Spraxidae, Streptaxidae, Strobilopsidae, Thysanophoridae, Vollonidae (Gastropoda) in Texas. Dallas Museum of Natural History, Bulletin I.

Geis, J.W.
1973 Biogenic Silica in Selected Species of Deciduous Angiosperms. Soil Science 116(2):113-119.

Gilbert, B. Miles
1969 Some Aspects of Diet and Butchering Techniques Among Prehistoric Indians in South Dakota. Plains Anthropologist 14(46):277-294.

1973 Mammalian Osteo-Archaeology: North America. The Missouri Archaeological Society, Columbia.

Giles, E. and O. Elliot
1963 Sex Determination by Discriminant Function Analysis of Crania. American Journal of Physical Anthropology 21(1):53-68.

Giddings, J.L. Jr.
1956 The Burin Spall Artifact. Arctic 9(4):229-237.

Gould, F.W.
1973 Common Texas Grasses. Texas A&M University Press, College Station.

Graham, A. and C. Heimsch
1960 Pollen Studies of Some Texas Peat Deposits. Ecology 41:751-763.

Grant, J.C.B.
1958 A Method of Anatomy. Williams & Wilkins, Baltimore.

Grayson, D.K.
1973 On the Methodology of Faunal Analysis. American Antiquity 38:432-439.

Green, L.M. and Thomas R. Hester
1973 The Finis Frost Site: A Toyah Phase Occupation in San Saba County, Central Texas: Bulletin of the Texas Archaeological Society 44:69-88.

Green, R.F., J. M. Suckey and D. V. Gokhale
1979 The Statistical Treatment of Correlated Bilateral Traits in the Analysis of Cranial Material. American Journal of Physical Anthropology 50:629-634.

Greene, D.G.
1967 Dentition of Meroitic, X-Group, and Christian Populations from Wadi Halfa, Sudan. Anthropological Papers No. 85, University of Utah Press, Salt Lake City.

Greer, John W.
1965 A Typology of Midden Circles and Mescal Pits. Southwestern Lore 31:41-55.

1968 Excavation at a Midden Circle Site in El Paso County, Texas. Bulletin of the Texas Archaeological Society 39:111-132.

1976 Neo-American Occupation at the Wheatley Site, Pedernales Falls State Park, Blanco County, Texas. Bulletin of the Texas Archeological Society 47:89-169.

Greer, John W., and Robert A. Benfer:
1975 Austin Phase Burials at the Pat Parker Site, Travis County, Texas. Bulletin of the Texas Archeological Society 46: 189-216.

Grinnell, G. B.
1904 The Bison. In Musk-Ox, Bison, Sheep and Goat by C. Whitney, G.B. Grinnell, and O. Wister, pp. 107-166. MacMillan Co., New York.

Guilford, J.P. and Benjamin Fruchter
1978 Fundamental Statistics in Psychology and Education (6th edition). McGraw-Hill, New York.

Gunn, Joel and Elton R. Prewitt
1975 Automatic Classification: Projectile Points from West Texas. Plains Anthropologist 20:139-149.

Gunnerson, D.A.
1972 Man and Bison on the Plains in the Protohistoric Period. Journal of the Plains Conference 17(55):1-9.

Hackett, Charles W., trans.
1931 Pichardo's Treatise on the Limits of Louisiana and Texas, I. University of Texas Press, Austin.

Hall, E. Raymond, and Keith R. Kelson
1959 The Mammals of North America. The Ronald Press Co., New York.

Harrell, Lynn
1980 Bone Tools. In Prehistory of Hog Creek: Archaeological Investigation of Bosque and Coryell Counties, Texas, edited by Donald O. Henry et al., Laboratory of Archaeology, Department of Anthropology, University of Tulsa, Tulsa OK.

Harvard, V.
1885 Report on the Flora of Western and Southern Texas. Proceeds of the United States National Museum 8:449-533.

Henderson, J., and J. P. Harrington
1914 Ethnozoology of the Tewa Indians. Smithsonian Institution, Bureau of American Ethnology Bulletin 56.

Henry, Don, F.E. Kirby, Anne Justen, and T.R. Hays
1980 Prehistory of Hog Creek - Archaeological Investigations of Bosque and Coryell Counties, Texas. Laboratory of Archaeology, Department of Anthropology, University of Tulsa.

Hester, Thomas R.
1970 Burned Rock Middens on the Southwestern Edge of the Edwards Plateau, Texas. Plains Anthropologist 15(1):237-249.

1971 Archaeological Investigations at the La Jita Site, Uvalde County, Texas. Bulletin of the Texas Archaeological Society 42:51-148.

1973 The Formation of a "Burned Rock Midden," a California Example. The Record, Dallas Archaeological Society 29:4.

1978 Early Human Occupations in South Central and Southwestern Texas: Preliminary Papers on the Baker Cave and St. Mary's Hall Sites. Center for Archaeological Research , The University of Texas at San Antonio.

1980 Digging into South Texas Prehistory. Corona Publishing Company, Sna Antonio.

Hester, T.R., O. Gilbow and A. Albee
1973 A Functional Analysis of "Clear Fork" Tools from the Rio Grande Plain, Texas. American Anthropologist 38:90-96.

Hester, T.R. and W.W. Birmingham
1976 Papers on Paleo-Indian Archaeology in Texas: I. Center for Archaeological Research Special Report No. 3, University of Texas at San Antonio.

Hester, T.R. and Michael B. Collins
1969 Burials from the Frisch Auf! Site: 41FY42. The Texas Journal of Sciences 20(3):261-272.

Hester, T.R. and Robert C. Parker
1970 The Berclair Site: A Late Prehistory Component in Goliad County, Southern Texas. Bulletin of the Texas Archeological Society 41:1-23.

Higgs, E. S. and C. Vita-Finzi
1972 Prehistoric economies in the Mount Carmel Area of Palestine: site catchment analysis. Proceedings of the Prehistoric Society, 36.

Highley, Lynn, Carol Graves, Carol Land and George Judson
1978 Archeological Investigations at Scorpion Cave (41WM37), Medina County, Texas. Bulletin of the Texas Archeological Society 49:139-194.

Hilliard, Jerry E.
1980 Prehistoric Ozark Settlement-Subsistence and Nut Resource Utilization. Unpublished Masters Thesis, Department of Anthropology, University of Arkansas.

Hornaday, W.T.
1889 The Extermination of the American Bison, with a Sketch of its Discovery and Life History. Report of the U.S. National Museum 2:367-548.

Howard, D. Calvin
1973 A Study of the Clear Fork Gouge. Bulletin of the Texas Archaeological Society 44:51-60.

Hughes, Jack T. and Patrick S. Willey
1978 Archeology at MacKenzie Reservoir. Texas Historical Commission, Office of the State Archeologist Archeological Survey Report 24.

Huskey, V.
1935 An Archaeological Survey of the Nueces Canyon of Texas. Bulletin of the Texas Archaeological and Paleontological Society 7:105-114.

Jackson, M. F.
1974 Archaeological Resources of the North Fork Reservoir Area: Results of Survey and Testing - 1970 Survey. Report submitted to the National Park Service by the Texas Archeological Survey, The University of Texas at Austin.

Jefferies, Richard W.
1978 Inter-site Activity Variability in the Lookout Valley Area of Northwest Georgia. Unpublished Ph.D. dissertation, Department of Anthropology, University of Georgia, Athens.

Jelks, Edward B.
1962 The Kyle Site: a Stratified Central Texas Aspect Site in Hill County, Texas. Department of Anthropology, University of Texas at Austin, Archaeology Series No. 5.

1978 Diablo Range. In Chronologies in New World Archeology, edited by R.E. Taylor and Clement W. Meighan. Academic Press, New York.

Jochim, Michael A.
1976 Hunter-gatherer Subsistence and Settlement: a Predictive Model. Academic Press, New York.

Johnson, Eileen M.
1976 Investigations into the Zooarchaeology of the Lubbock Lake Site. Unpublished Ph.D. dissertation, Department of Anthropology, Texas Tech University.

1977 Animal Food Resources of Paleoindians. The Museum Journal XVII: 65-77.

Johnson, Leroy Jr.
1964 The Devil's Mouth Site: A Stratified Campsite at Amistad Reservoir, Val Verde County, Texas. Department of Anthropology, University of Texas at Austin, Archaeology Series No. 6.

1967 Toward a Statistical Overview of the Archaic Cultures of Central and Southwestern Texas. Bulletin 12, Texas Memorial Museum, Austin.

Johnson, LeRoy Jr., Dee Ann Suhm, and Curtis D. Tunnell
1962 Salvage Archeology of Canyon Reservoir: the Wunderlich, Footbridge and Oblate Sites. Texas Memorial Museum, Bulletin No. 5.

Jones, J.K.
1964 Distribution and Taxonomy of Mammals of Nebraska. University of Kansas Press, Lawrence.

Jones, Robert L., and A.H. Beavers
Aspects of Catenary and Depth Distribution of Opal Phytoliths in Illinois Soils. Soil Science Society of America Proceedings 28(3):413-416.

Kelley, J. Charles
1947a The Lehmann Rock Shelter: A Stratified Site of the Toyah, Uvalde, and Round Rock Foci. Bulletin of the Texas Archeological and Paleontological Society 18:115-128.

1947b The Cultural Affiliations and Chronological Positions of the Clear Fork Focus. American Antiquity 13(2):97-109.

1959 The Desert Cultures and the Balcones Phase: Archaic Manifestations in the Southwest and Texas. American Antiquity 24(3):276-288.

Kelley, J. Charles and T.N. Campbell
1942 What are the Burned-Rock Mounds of Texas? American Antiquity 7:319-322.

Kelly, Thomas C.
1961 The Crumley Site: A Stratified Burnt Rock Midden, Travis County, Texas. Bulletin of the Texas Archeological Society 31:239-272.

Kemp, R.J.
1971 The Freshwater Fishes of Texas. Texas Parks and Wildlife Department, Bulletin 5-A.

Jochim, Michael A.
1976 Hunter-gatherer Subsistence and Settlement: a Predictive Model. Academic Press, New York.

Johnson, Eileen M.
1976 Investigations into the Zooarchaeology of the Lubbock Lake Site. Unpublished Ph.D. dissertation, Department of Anthropology, Texas Tech University.

1977 Animal Food Resources of Paleoindians. The Museum Journal XVII: 65-77.

Johnson, Leroy Jr.
1964 The Devil's Mouth Site: A Stratified Campsite at Amistad Reservoir, Val Verde County, Texas. Department of Anthropology, University of Texas at Austin, Archaeology Series No. 6.

1967 Toward a Statistical Overview of the Archaic Cultures of Central and Southwestern Texas. Bulletin 12, Texas Memorial Museum, Austin.

Johnson, LeRoy Jr., Dee Ann Suhm, and Curtis D. Tunnell
1962 Salvage Archeology of Canyon Reservoir: the Wunderlich, Footbridge and Oblate Sites. Texas Memorial Museum, Bulletin No. 5.

Jones, J.K.
1964 Distribution and Taxonomy of Mammals of Nebraska. University of Kansas Press, Lawrence.

Jones, Robert L., and A.H. Beavers
Aspects of Catenary and Depth Distribution of Opal Phytoliths in Illinois Soils. Soil Science Society of America Proceedings 28(3):413-416.

Kelley, J. Charles
1947a The Lehmann Rock Shelter: A Stratified Site of the Toyah, Uvalde, and Round Rock Foci. Bulletin of the Texas Archeological and Paleontological Society 18:115-128.

1947b The Cultural Affiliations and Chronological Positions of the Clear Fork Focus. American Antiquity 13(2):97-109.

1959 The Desert Cultures and the Balcones Phase: Archaic Manifestations in the Southwest and Texas. American Antiquity 24(3):276-288.

Kelley, J. Charles and T.N. Campbell
1942 What are the Burned-Rock Mounds of Texas? American Antiquity 7:319-322.

Kelly, Thomas C.
1961 The Crumley Site: A Stratified Burnt Rock Midden, Travis County, Texas. Bulletin of the Texas Archeological Society 31:239-272.

Kemp, R.J.
1971 The Freshwater Fishes of Texas. Texas Parks and Wildlife Department, Bulletin 5-A.

Korey, K.A.
1980 The Incidence of Bilateral Nonmetric Skeletal Traits: a Reanalysis of Sampling Procedures. American Journal of Physical Anthropology 50:629-634.

Krieger, Alex D.
1944 The Typological Concept. American Antiquity 9:271-288.

1953 New World Culture History: Anglo-America. In Anthropology Today, edited by A.L.Kroeber, pp. 238-264. University of Chicago Press, Chicago.

Kroeber, A. L.
1939 Cultural and Natural Areas of Native North America. University of California Publications in American Archaeology and Ethnology, 38. Berkeley.

Larson, D.S., V.M. Bryant, and T.S. Patty
1972 Pollen analysis of a Central Texas Bog. American Midland Naturalist 88:358-367.

Lawrence, Barbara
1951 Post-cranial Skeletal Characters of Deer, Pronghorn, and Sheep-goat with notes on Bos and Bison, Part II. Papers of the Peabody Museum of Archaeology and Ethnology 35(3):9-43.

Lee, Richard B.
1968 What Hunters Do for a Living, or, How to Make Out on Scarce Resources. In Man the Hunter, edited by Richard Lee and Irven DeVore, pp. 30-48. Aldine Publishing Company, Chicago.

Leechman, Douglas
1968 Bone Grease. American Antiquity 16(1):355-356.

Limp, F.J. and Van A. Reidhead
1979 An Economic Evaluation of the Potential of Fish Utilization in Riverine Environments. American Antiquity 44(1):70-78.

Lowie, Robert H.
1963 Indians of the Plains. The Natural History Press, Garden City, New York.

Luke, Clive J.
1980 Continuing Archeology on State Highway 16 in Kerr County, Texas: The Excavations of the Shep Site (41KR109) and the Wounded Eye Site (41KR107). Texas State Department of Highways and Public Transportation, Publications in Archeology Report No. 16.

Lundelius, E.L. Jr.
1967 Late-Pleistocene and Holocene Faunal History of Central Texas. In Pleistocene extinctions, the search for a cause, edited by P.S. Martin, and H.E. Wright, Jr., pp.287-319. Yale University Press, New Haven.

Lyman, R. Lee
1980 Inference from Bone Distributions in Prehistoric Sites in the Lower Granite Reservoir Area, Southeastern Washington. Northwest Anthropology Notes 14(1):107-123.

Lynch, D.
1962 Study of a Grassland Mosaic at Austin, Texas. Ecology 43:679-686.

Lynott, Mark J.
1978 An Archaeological Assessment of the Bear Creek Shelter, Lake Whitney, Texas. Archaeology Research Program Research Report 115, Southern Methodist University.

Lynott, Mark J. and Duane E. Peter
1977 1975 Archaeological Investigations at Aquilla Lake, Texas. Archaeology Research Program Research Report 100, Southern Methodist University.

Luchterhand, Kubet
1970 Early Archaic Projectile Points and Hunting Patterns in the Lower Illinois Valley. Illinois Archaeological Survey Monograph No. 2.

Mahmoud, I.Y.
1969 Comparative Ecology of the Kinosternid Turtles of Oklahoma. Southwest Naturalist 14:31-66.

Mallouf, Michael G.
1977 Archeological Investigations at Lake Limestone, Fall and Winter, 1977. Texas Archeological Survey Research Report No. 71, University of Texas, Austin.

Martin, C. Alexander and W.D. Barkley
1961 Seed Identification Manual. University of California Press, Berkeley.

McGinley, Ann Neil
1978 Elemental Analysis of Edwards Formation Flint: a Comparison of Sample Areas. Unpublished M.A. Thesis, Texas A&M University.

McGinley, Ann Neil and E. A. Schweikert
1979 Neutron Activation Analysis of Flints from the Edwards Formation. Journal of Radioanalytical Chemistry 52(1):101-110.

McHugh, Tom
1972 The Time of the Buffalo. Alfred A. Knopf, New York.

McKern, T.W. and T.D. Stewart
1957 Skeletal Age Changes in Young American Males. Headquarters, Quartermaster Research and Development Command, Technical Report E, P-45, Natick, Mass.

McKern, W.C.
1939 The Midwestern Taxonomic Method as Aid to Archaeological Culture Study. American Antiquity 4:301-313.

McMillan, R. Bruce
1976 The Dynamics of Cultural and Environmental Change at Rodgers Shelter, Missouri. In Prehistoric Man and His Environments: a Case Study in the Ozark Highland, edited by W. Raymond Wood and R. Bruce McMillan, pp. 211-234. Academic Press, New York.

Merriam, C.H.
1898 Life Zones and Crop Zones of the United States, U.S. Biological Survey No. 10.

Metcalf, C.R.
1960 Anatomy of the Monocotyledons: I. Gramineae. Oxford Univeristy Press, London.

Montet-White, Anta
1973 Le Malpas Rockshelter. University of Kansas Publication in Anthropology No. 4.

1974 Significance of Variability in Archaic Point Assemblages. Plains Anthropologist 19(63):14-24.

Moore, Gary L.
1977 An Archeological Assessment of Sites 41WM21, 41WM124, and 41WM133 in Granger Reservoir, Williamson County, Texas. Report submitted to the National Park Service, by the Anthropology Laboratory, Texas A&M University.

Moore, G. L., H. J. Shafer, and C. S. Weed
1978 Archeological Surveys of Granger and North Fork Reservoirs: Volume I, The Granger Report. Anthropology Research Laboratory Report NO. 38a, Texas A & M University.

Munson, P.J., and W.F. Limp
n.d. Faunal Analysis and Sample Size: Some Problems and Some Suggested Correction Factors. Manuscript on file, Institute of Applied Sciences, North Texas State University.

Murry, Phillip A.
1978 Analysis of Vertebrate Faunal Remains. In Archaeological Assessment of the Bear Creek Shelter, Lake Whitney, Texas, by Mark Lynott, pp. 48-70. Southern Methodist University, Archaeology Research Program Research Report 115.

Musil F. Albina
1963 Identification of Crop and Weed Seeds. Agriculture Handbook No. 219, U.S. Department of Agriculture.

Newcomer, M.H.
1974 Study and Replication of Bone Tools from Ksar Akil (Lebanon). World Archaeology 6(2):138-153.

Newcomb, W.W. Jr.
1969 The Indians of Texas: from Prehistoric to Modern Times. University of Texas Press, Austin.

Nie, Norman H., C. Hadlai Hull, Jean G. Jenkins, Karin Steinbrenner, and Dale H. Bent

1975 SPSS: Statistical Package for the Social Sciences (Second Edition). McGraw-Hill, Inc., New York.

Olsen, S.J.

1960 Post-cranial Skeletal Characteristics of Bison and Bos. Papers of the Peabody Museum of Archaeology and Ethnology 35(4):1-64.

1964 Mammal Remains form Archaeological Sites, Part I: Southwestern United States. Papers of the Peabody Museum of Archaeology and Ethnology 56(1):1-162.

1968 Fish, Amphibian, and Reptile Remains from Archaeological Sites, Part I: Southeastern and Southwestern United States. Papers of the Peabody Museum of Archaeology and Ethnology 56(2): 1-103.

Olsen, Sandra L.

1979 A Study of Bone Artifacts from Grasshopper Pueblo, AZ, pp. 14:1. The Kiva 44(4):341-373.

Olsen, S.J. and R.P. Wheeler

1978 Bones from Awatovi. Papers of the Peabody Museum of Archaeology and Ethnology 70(2):35-74.

Opler, Morris

1941 An Apache Life-way. University of Chicago Press, Chicago.

Ossenberg, N.S.

1981 An Argument for the Use of Total Side Frequencies of Bilateral Non-metric Skeletal Trait in Population Distance Analysis: The Regression of Symmetry on Incidence. American Journal of Physical Anthropology 54(4):471-479.

Parmalee,Paul W.

1977 The Avifauna from Prehistoric Arikara Sites in South Dakota. Plains Anthropologist 22(77):189-222.

Patterson, J.R.

1936 The Corner-tang Flint Artifacts of Texas. University of Texas Bulletin No. 3618.

Patterson, Patience E.

1977 A Lithic Reduction Sequence: A Test Case in the North Fork Reservoir Area, Williamson County, Texas. Bulletin of the Texas Archeological Society 48: 53-82.

Patterson, P. E. and G. L. Moore

1976 An Archeological Study of North Fork and Granger Reservoirs, A Preliminary Report. Anthropology Research Laboratory Report No. 34. Texas A & M University.

Patterson, P. E. and H. J. Shafer
1980 Archeological Surveys of Granger and North Fork Reservoirs: Volume II, the North Fork Report. Anthropological Research Laboratory Report No. 38b. Texas A & M University.

Pearce, J.E.
1919 Indian Mounds and Other Relics of Indian Life in Texas. American Anthropologist 21(3):223-234.

Pearce, J.E.
1932 The Present Status of Texas Archeology. Bulletin of the Texas Archeological and Paleontological Society 4:44-54.

Pearsall, Deborah M.
1978 Phytolith Analysis of Archeological Soils: Evidence for Maize Cultivation in Formative Ecuador. Science 199:177-178.

Peters, Ilse
1968 Opalphytolithe-Ihre Brauchbarkeit ünd Verwendungsmöglichkeitenals Pflanzliche Mikrofossilen. Institut Für Ur-Und Frühgeschichte, Köln, Paleontographics Abt.B, Lief. 1-6:243-256.

Peterson, R.T.
1963 A Field Guide to the Birds of Texas. Houghton Mifflin Co., Boston.

Pilsbry, H.A.
1948 Land Mollusca of North America (North of Mexico): Volume 2, Part 2. Academy of National Science of Philadelphia, Monograph 3.

Pinkham, C.F.A. and J.G. Pearson
1974 A New Measure of Biotic Similarity Between Samples and Its Application with a Cluster Analysis Program. Edgewood Arsenal Technical Report EB-TR-74062, Department of the Army.

Pitts, M.W.
1978 On the Shape of Waste Flakes as an Index of Technological Change in Lithic Industries. Journal of Archaeological Science 5:17-37.

Pitzer, M. Jean (Editor)
1977 Basic Sources for the Study of Burins. Archaeological Research Facility, University of California.

Potzger, J.E. and B.C. Tharp
1943 Pollen Record of Canadian Spruce and Fir from Texas Bog. Scien ? 98:584.

1947 Pollen Profile from a Texas Bog. Ecology 28:274-280.

Potzger, J.E. and G.C. Tharp
1954 Pollen Study of Two Bogs in Texas. Ecology 35:462-466.

Presslar, Tony
1977 Micromagnetic Surveying: An Overview. In Brethauer and Pressler, Report 77SJC-013. New Mexico State University, San Juan Campus.

Preston, Nolan E.
1969 The McCann Site. Bulletin of the Texas Archaeological Society 40:167-192.

Prewitt, Elton R.
1966 A Preliminary Report on the Devil's Rockshelter Site, Val Verde County, Texas. The Texas Journal of Science 18(2):206-224.

1974a Archeological Investigations at the Loeve-Fox Site, Williamson County, Texas. Texas Archeological Survey Research Report No. 49, University of Texas at Austin.

1974b Upper Navasota Reservoir: An Archeological Assessment. Research Report No. 47, Texas Archaeological Survey, The University of Texas at Austin.

1976a Late Archaic Occupations at the Loeve-Fox Site: the San Marcos and Twin Sisters Phases. In the Texas Archaic: a symposium, edited by T.R. Hester, pp. 67-82. University of Texas at San Antonio Special Report No. 2.

1976b The Rogers Spring Site: 1974 Investigations. Ms. on file, Texas Archeological Survey, University of Texas at Austin.

1981 Cultural Chronology in Central Texas. Bulletin of the Texas Archeological Society 52, in press.

Prewitt, Elton R. and Linda A. Nance
1980 Archeological Survey and Assessments on the McBryde Lease, Duval County, Texas. Prewitt and Associates, Inc., Reports of Investigations No. 7.

Ray, N. Cyrus
1941 Various Types of the Clear Fork Gourge. Bulletin of the Texas Archaeological and Paleontological Society 13:173-178.

Read, Dwight W.
1974 Some Comments on Typologies in Archaeology and an Outline of a Methodology. American Antiquity 39(2):216-242.

Redman, Charles
1973 Multistage Fieldwork and Analytical Techniques. American Antiquity 38:61-79.

Reher, Charles A., and George C. Frison
1980 The Vore Site, 48CK302, a Stratified Buffalo Jump in the Wyoming Black Hills. Plains Anthropologist Memoir 16(2):25-88.

Renfrew, M. Jane
1973 Palaeoethnobotany: The Prehistoric Food Plants of the Near East and Europe. Columbia University Press, New York.

Rightmire, G.P.
1970 Iron Age Skulls from South Africa Reassessed by Multiple Discriminate Analysis. American Journal of Physical Anthropology 33(2):147-168.

Robbins, C.B., B. Brun, and H.S. Zim
1966 Birds of North America. Golden Press, New York.

Roe, Frank G.
1951 The North American Buffalo: A Critical Study of the Species in the Wild State. University of Toronto Press, Toronto.

Rovner, Irwin
1971 Potential of Opal Phytoliths for Use in Paleoecological Reconstruction. Quaternary Research 1:343-359.

1980 An Application of Bordes' Paleolithic Handaxe Typology to the Study of Classic Maya Lithics. Lithic Technology 9(1):26-29.

Rummel, R.J.
1970 Applied Factor Analysis. Northwestern University Press, Evanston.

Ryder, M.L.
1968 Animal Bones in Archaeology. Blackwell Scientific Publications, Oxford.

Sackett, James R.
1966 Quantitative Analysis of Upper Paleolithic Stone Tools. American Anthropologist 68:356-394.

Sayles, E.B.
1935 An Archeological Survey of Texas. Medallion Papers 17. Gila Pueblo, Globe, Arizona.

Schiffer, Michael B.
1976 Behavioral Archeology. Academic Press, New York.

Schild, Romuald
1976 The Final Paleolithic Settlements of the European Plain. Scientific American 234(2):88-99.

Schmid, E.F.
1972 Atlas of Animal Bones. American Elsevier Publishing Company, Inc., New York.

Schorger, A.W.
1966 The Wild Turkey, Its History and Domestication. University of Oklahoma Press, Stillwater.

Sellards, E.H., W.S. Adkins, and F.B. Plummer
1958 The Geology of Texas: *Volume 1 Stratigraphy.* University of Texas Bulletin No. 3232 (August 22, 1932), University of Texas, Austin, Fourth Printing.

Service, Elman R.
1964 Archaeological Theory and Ethnological Fact. In Process and Pattern in Culture, edited by R. A. Manners, pp. 364-75. Aldine, Chicago.

Severinghaus, C. W.
1949 Tooth Development and Wear as Criteria of Age in White-tailed Deer. The Journal of Wildlife Management 13(2):195-216.

Shafer, Harry J.
1963 Text Excavations at the *Youngsport Site: A Stratified Terrace* Site in Bell County, Texas. Bulletin of the Texas Archeological Society 34:57-81.

1970 Notes on Uniface Retouch Technology. American Antiquity 35:480-487.

1975 Ring-shaped Burned Rock Middens in Brown and Comanche Counties, Texas. Newsletter of the Central Texas Archeological Society, Vol 9.

Shafer, H. J., E. P. Baxter, John Ippolito and Clell L. Bond
1978 Archeological Test Excavations at 41WM21 in Granger Reservoir, Williamson County, Texas. Report No. 37 (Revised), Anthropology Department, Texas A & M University.

Shafer, Harry J. and James E. Corbin
1965 Appraisal of the Archeological Resources of North Fork, South Fork, and Laneport Reservoir, Williamson County, Texas. Report submitted to the National Park Service by the Texas Archeological Salvage Project, University of Texas at Austin.

Shafer Harry, J., Dee Ann Suhm, and J. Dan Scurlock
1964 An Investigation and Appraisal of the Archeological Resources of Belton Reservoir, Bell and Coryell Counties, Texas: 1962. Texas Archeological Salvage Project, Miscellaneous Papers No. 1.

Shafer, H. J. and V. M. Bryant, Jr.
1976 A Preliminary Assessment of Cultural Resources in the North Fork and Granger Reservoir, Williamson Co., Texas. A Supplemental Report to "An Archeological Survey of Granger and North Fork Reservoir, Preliminary Report" submitted to the National Park Service by the Anthropology Research Laboratory, Texas A&M University.

Shelford, Victor E.
1963 The Ecology of North America. The University of Illinois Press, Urbana, Illinois.

Shiner, Joel L.
1968 The Cataract Tradition. In The Prehistory of Nubia, Vol. II, edited by Fred Wendorf, pp. 535-629. Southern Methodist University Press, Dallas.

Siegel, Sidney
1956 Nonparametric Statistics for the Behavioral Sciences. McGraw-Hill Book Company, Inc., New York.

Simpson, C. T.
1914 A Descriptive Catalogue of the Naiades or Pearly Fresh-water Mussels. B. Walker, Detroit.

Skinner, S. A.
1974 Prehistoric Settlement of a "Natural Area." Ph.D. dissertation, Department of Anthropology, Southern Methodist University.

Skinner, S. Alan and Joseph Gallagher
1974 An Evaluation of the Archaeological Resources at Lake Whitney, Texas. Southern Methodist University Contributions in Anthropology No. 14.

Slaughter, B.H. and B.R. Hoover
1963 Sulphur River Formation and the Pleistocene Mammals of the Ben Franklin Local Fauna. Journal of Graduate Research Center 31:132-148.

Soil Survey Staff
1975 Soil Taxonomy. Agricultures Handbook No. 436, Soil Conservataion Service, U.S.D.A. U.S. Govt. Printing Office, Washington, D. C.

Sokal, R. and P. Sneath
1963 Principles of Numerical Taxonomy. Freeman, San Francisco.

Sollberger, J.B. and T.R. Hester
1972 The Strohacker Site: A Review of Pre-Archaic Manifestations in Texas. Plains Anthropologist 17(58): 326-344.

Sorrow, William M.
1969 Archeological Investigations at the John Ischy Site: A Burnt Rock Midden in Williamson County, Texas. Texas Archeological Salvage Project Papers No. 18, University of Texas at Austin.

1970 Archeological Investigations at the Barker Site. Texas Archeological Salvage Project Research Report No. 1. University of Texas at Austin.

1973 Test Excavations in the North Fork Reservoir Area. Unpublished report submitted to the National Park Service by the Texas Archeological Survey, the University of Texas at Austin.

Sorrow, William M., Harry J. Shafer, and Richard E. Ross
1967 Excavations at Stillhouse Hollow Reservoir, Papers of the Texas Archeological Salvage Project No. 11, University of Texas at Austin.

Spaulding, A.
1953 Statistical Techniques for the Discovery of Artifact Types. American Antiquity 18:305-313.

Stafford, C. Russell and Barbara D. Stafford
1979 Some Issues Concerning the Design of Lithic Experiments. Lithic Technology 8(2):21-24

Steward, Julian H.
1933 Ethnography of the Owens Valley Paiute. University of California Publications in American Archaeology and Ethnology No. 33.

1954 Types of Types. American Anthropologist 55:54-57.

Stoltman, James B.
1978 Temporal Models in Prehistory: An Example from Eastern North America. Current Anthropology 19(4):703-746.

Story, Dee Ann and Harry J. Shafer
1965 1964 Excavations at Waco Reservoir, McLennan County, Texas: The Baylor and Britton Sites. Texas Archeological Salvage Project, Miscellaneous Papers No. 6.

Strecker, J.K.
1931 The Distribution of the Naiades or Pearly Fresh-water Mussels of Texas. Baylor University Museum, Special Bulletin No. 2.

Suess, E.
1966 Opal Phytoliths. Unpublished M.S. Thesis, Kansas State University.

Suhm, Dee Ann
1957 Excavations at the Smith Rockshelter, Travis County, Texas. The Texas Journal of Science 9(1):26-58.

1959 The Williams Site and Central Texas Archeology. The Texas Journal of Science 11(2):218-250.

Suhm, Dee Ann
1960 A Review of Central Texas Archeology. Bulletin of the Texas Archeological Society, Vol. 29:63-108.

Suhm, D. A. and E. B. Jelks
1962 Handbook of Texas Archeology Type Descriptions. Texas Memorial Museum Bulletin No. 4, and Texas Archeological Society Special Publication, No. 1.

Suhm, Dee Ann, Alex D. Krieger and Edward B. Jelks
1954 An Introductory Handbook of Texas Archeology. Bulletin of the Texas Archeological Society 25.

Sullivan, Tim, T.R. Hays and G.K. Humphreys
1976 Archaeological Testing at the North Fork Reservoir District, Central Texas. Report Submitted to U.S. Army Corps of Engineers, Fort Worth District by the Archaeology Program, IAS, NTSU, Denton, Texas.

Templin, E.H., A.H. Bean, J.W. Huckabee Jr., L.H. Smith and M.H. Layton
1934 Soil Survey of Williamson County, Texas. United States Department of Agriculture, Bureau of Chemistry and Soils in Cooperation with Texas Agricultural Experimental Station No. 10.

Tharp, B.C.
1939 The Vegetation of Texas, Texas Academy of Science Publications in Natural History, Non-Technical Series 1.

1952 Texas Range Grasses. University of Texas Press, Austin.

Thomas, D.H.
1972 The Use and Abuse of Numerical Taxonomy in Archaeology. Archaeology and Physical Anthropology in Oceania 7:31-49.

Thornwaite, C.W.
1948 An Approach Toward a Rational Classification of Climate. Geographical Review 38:55-94.

Tixier, Jacques
1963 Typologie de l'epilaleolithique du Magreb. Paris, Arts et métiers graphiques.

1974 Glossary for the Description of Stone Tools. Newsletter of Lithic Technology, Special Publication Number 1, Washington State University, Pullman, Washington. Translated by M.H. Newcomer.

Tringham, Ruth, Glen Cooper, George Odell, Barbara Voytek and Anne Whitman
1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. Journal of Field Archaeology 1:171-196.

Trotter, M. and G. C. Glester
1952 Estimation of Stature from Long Bones of American Whites and Negroes. American Journal of Physical Anthropology, 10:463-514.

Twiss, P.C., E. Suess and R.M. Smith
1969 Morphological Classification of Grass Phytoliths. Soil Science Society of America Proceedings 33:109-114.

Ubelaker, D.
1978 Human Skeletal Remains: Excavation, Analysis, Interpretation. Aldine Publishing Company, Chicago.

U. S. Corps of Engineers
1977 Scope of Work. Archaeological Investigations at the San Gabriel Reservoir Districts, Williamson County, Texas. Fort Worth District.

U.S. Department of Agriculture
1974 Seeds of Woody Plants in the United States. Agriculture Handbook No. 450, Washington, D.C.

Vehik, Susan C.
1977 Bone Fragments and Bone Grease Manufacturing: A Review of their Archaeological Use and Potential. Plains Anthropologist 22:169-182.

Vines, R.A.
1960 Trees, Shrubs, and Woody Vines of the Southwest. University of Texas Press, Austin.

Von den Driesch, Angela
1976 A Guide to the Measurement of Animal Bones from Archaeological Sites. Papers of the Peabody Museum of Archaeology and Ethnology, Bulletin 1.

Watt, Frank H.
1968 A Prehistoric Shelter Burial in Bell County, Texas. Bulletin of the Central Texas Archeological Society 2:3-58.

Weaver, J.E. and F.E. Clements
1938 Plant Ecology (2nd Edition). McGraw Hill, New York.

Weir, Frank A.
1976 The Central Texas Archaic. Unpublished Ph.D. Dissertation, Department of Anthropology, Washington State University.

1979 Greenhaw: An Archaic Site in Central Texas. Bulletin of the Texas Archeological Society 50:5-67.

Wendorf, Fred
1968 The Prehistory of Nubia. Southern Methodist University Press, Dallas.

Wesolowsky, Al B., Thomas R. Hester and Douglas R. Brown
1976 Archeological Investigations at the Jetta Court Site (41TV151), Travis County, Texas. Bulletin of the Texas Archeological Society 47:25-87.

White, J.P. and D.H. Thomas
1972 What Mean These Stones? Ethno-taxonomic models and Archaeological Interpretations in the New Guinea Highlands. In Models in Archaeology, edited by David L. Clarke, pp. 275-308. Methuen, London.

White, Theodore E.
1955 Observations on the Butchering Techniques of Some Aboriginal Peoples. Nos. 7,8, and 9. American Antiquity 21(2):170-178.

Whitthoft, John
1967 Glazed Polish on Flint Tools. American Antiquity 32:383-388.

Wilding, L.P. and L.R. Drees
1968 Biogenic Opal in Soils as an Index of Vegetative History in the Prairie Peninsula. The Quaternary of Illinois, University of Illinois College of Agriculture Special Publication 14.

1971 Biogenic Opal in Ohio Soils. Soil Science Society of America Proceedings 35:1004-1010.

1973 Scanning Electron Microscopy of Opaque Opaune Forms Isolated From Forest Soils in Ohio. Soil Science Society of America Proceedings 37(4):647-650.

Wilkinson, R.G.
1970 Biological Relationships among Middle and Late Woodland Populations in the Great Lakes Region. Ph.D. dissertion, University of Michigan.

Willey, Gordon R. and Philip Phillips
1958 Method and Theory in American Archeology. The University of Chicago Press, Chicago.

Williams-Dean, G.
1978 Ethnobotany and Cultural Ecology of Prehistoric Man in Southwest Texas. Unpublished Ph.D. disseration, Department of Botany, Texas A&M University.

Willimon, E.L
1972 New Local Faunas and Paleoecology (Pleistocene) of North Central Texas Texas Journal of Science 23:449-469.

Wilmsen, E.N.
1970 Lithic Analysis and Cultural Inference: A Paleo-Indian Case. Anthropological Papers of the University of Arizona No. 16.

Wilson, E.W.
1930 Burned Rock Mounds of Southwest Texas. Bulletin of the Texas Archeological and Paleontological Society 2:59-63.

Wing, E.S., and A.B. Brown
1979 Paleonutrition, Method and Theory in Prehistoric Foodways. Academic Press, New York.

Witter, Dan C.
1973 Analysis and Interpretation of the Vertebrate Remains from 41WM135. In Salvage Archeology in Laneport Reservoir District in Central Texas by F.W. Eddy. Texas Archeological Survey, Austin.

Witty, John E. and Ellis G. Knox
1964 Grass Opal in Some Chestnut and Forested Soils in North Central Oregon. Soil Science Society of America Proceedings 28:685-687.

Wobst, H.M.
1974 Boundary Conditions for Paleolithic Social Systems: A Simulation Approach. American Antiquity 39.

Word, J.H. and C.L. Douglas
1970 Excavations at Baker Cave, VAl, Verde County, Texas. Texas Memerial Museum Bulletin No. 16.

Yarnell, Asa Richard
1964 Aboriginal Relationships between Culture and Plant life in the Upper Great Lakes Region. Anthropological Papers of the Museum of Anthropology No. 23. University of Michigan, Ann Arbor.

Yeck, R.D.
1969 Selected Characteristics of Opaline Phytoliths Between Some Udolls and Usolls. Ph.D. dissertation, Oklahoma State University.

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